REPORT RESUMES

ED 014 907 56 EM 006 008

INSTRUCTIONAL ILLUSTRATIONS--A SURVEY OF TYPES OCCURRING IN PRINT MATERIALS FOR FOUR SUBJECT AREAS.

BY- FLEMING, MALCOLM L.
INDIANA UNIV., BLOOMINGTON
REPORT NUMBER NDEA-VIIA-1381 PUB DATE NOV 66
REPORT NUMBER BR-5-0512
GRANT OEG-7-24-0210-279
EDRS PRICE MF-$1.75 HC-$17.52 436P.

DESCRIPTORS- TESTS OF SIGNIFICANCE, *ILLUSTRATIONS, *TEXTBOOK EVALUATION, *TAXONOMY, *COMPARATIVE ANALYSIS

OBJECTIVES OF THIS STUDY WERE TO DESIGN AND TEST A TAXONOMY OF ILLUSTRATIONS OF 4 TYPES--PHYSICAL (PICTURES), VERBAL MODIFIER (CAPTION), EDUCATIONAL OBJECTIVE, AND SUBJECT MATTER. CHI-SQUARE ANALYSIS OF ASSOCIATION AMONG THE TYPES IN A SAMPLE OF 40 GRADE 8 TEXTS IN 4 SUBJECT AREAS WOULD SUGGEST HYPOTHESES FOR FURTHER SYSTEMATIC RESEARCH RELATING ILLUSTRATIONS TO STUDENT LEARNING AND PERCEPTION. A PROPORTIONAL RANDOM SAMPLE OF 787 ILLUSTRATIONS WAS DRAWN FROM ENGLISH, HISTORY, MATH AND SCIENCE TEXTS THAT WERE ASSUMED TO REPRESENT A RANGE OF ILLUSTRATION TYPES. THE PHYSICAL AND THE OBJECTIVE TYPES IN THE ILLUSTRATIONS WERE NOMINALLY CLASSIFIED BY TEACHER-JUDGES WITH RELIABILITY IN SOME INSTANCES AS LOW AS .55. MANY SIGNIFICANT ASSOCIATIONS WERE FOUND IN 101 CHI-SQUARE ANALYSES UNDER 5 HEADINGS, WITH THESE GENERAL CONCLUSIONS. SUBJECT MATTER WAS SIGNIFICANTLY ASSOCIATED WITH EDUCATIONAL OBJECTIVE TYPE ILLUSTRATIONS, AND WITH PHYSICAL ATTRIBUTES AND VERBAL MODIFIERS OF ILLUSTRATIONS. PHYSICAL ATTRIBUTES AND VERBAL MODIFIERS WERE SIGNIFICANTLY ASSOCIATED WITH THE KNOWLEDGE, ANALYSIS, SYNTHESIS, APPLICATION, AND APPRECIATION OBJECTIVES OF THE ILLUSTRATIONS, AND WITH THEIR LEVELS OF INVOLVEMENT (RELATIVE DIFFICULTY OF OBJECTIVES). (LH)

ED014907

A

FINAL REPORT / PROJECT NO. 1381 NDEA TITLE VIIA, GRANT OE-7-24-0210-279

[redacted]

EM006008

BR-5-0512

PA 56

INSTRUCTIONAL ILLUSTRATIONS: A SURVEY OF TYPES OCCURRING IN PRINT MATERIALS FOR FOUR SUBJECT AREAS

with
Taxonomies of Physical Attributes,
Verbal Modifiers,
and
Behavioral Objectives

November, 1966

U.S. DEPARTMENT OF
HEALTH, EDUCATION, & WELFARE
Office of Education
Bureau of Research

INSTRUCTIONAL ILLUSTRATIONS:
A SURVEY OF TYPES OCCURRING IN PRINT MATERIALS FOR FOUR SUBJECT AREAS

U.S. DEPARTMENT OF HEALTH, EDUCATION & WELFARE
OFFICE OF EDUCATION

THIS DOCUMENT HAS BEEN REPRODUCED EXACTLY AS RECEIVED FROM THE PERSON OR ORGANIZATION ORIGINATING IT. POINTS OF VIEW OR OPINIONS STATED DO NOT NECESSARILY REPRESENT OFFICIAL OFFICE OF EDUCATION POSITION OR POLICY.

Project No. NDEA Title VII A Project 1381
Grant No. OE-7-24-0210-279

Malcolm L. Fleming
Principal Investigator

November 1966

The research reported herein was performed pursuant to a grant with the Office of Education, U.S. Department of Health, Education, and Welfare. Contractors undertaking such projects under Government sponsorship are encouraged to express freely their professional judgment in the conduct of the project. Points of view or opinions stated do not, therefore, necessarily represent official Office of Education position or policy.

Indiana University
Audio-Visual Center

Bloomington, Indiana

EM 006 008

Acknowledgments

This is to acknowledge the many contributions to this project by the following team whose diverse talents made possible its successful completion:

Dr. Beryl Blain, Associate Professor, Indiana University, Division of Educational Media, School of Education, Coordinator of Text Materials Program, AID and former elementary teacher of English and Social Studies.

Dr. Lester Satterthwaite, Assistant Professor, Indiana University, Division of Educational Media, School of Education, Director of Animation, instructor of course in graphics for teachers, former television director and artist.

Mr. Richard Dowell, Ed.D. candidate in Science Education, secondary teacher of Biology and Chemistry for 12 years, Indianapolis Public Schools.

Mr. Abdullah Elerian, Ph.D. candidate in Audio-Visual Education, former teacher of Arabic, on leave from the faculty of Education, Ain-Shams University, Cairo, Egypt.

Mr. Gerry B. Mendelson, Ed.D. candidate in Audio-Visual Education, former elementary and junior high school art teacher, assistant professor in art education.

Mrs. Leatha Brittain, Secretary

Dr. Blain, Mr. Dowell, and Mr. Elerian were responsible primarily for the Objective Type Taxonomy and the Verbal Modifier Taxonomy, while Dr. Satterthwaite and Mr. Mendelson were responsible primarily for the Physical Type Taxonomy. Mr. Elerian performed the statistical analyses. Dr. Lawson Hughes served as statistical consultant. Dr. Blain served as the editor of the final report.

The project staff are indebted to the administration and certain teachers of English, history, mathematics and science from the following:

Bloomington Metropolitan Schools, Bloomington, Indiana
Lakeland School Corporation, LaGrange, Indiana
Indianapolis City Schools, Indianapolis, Indiana

TABLE OF CONTENTS

Chapter Page

I. INTRODUCTION 1

II. OBJECTIVES 3

III. INITIAL PROCEDURES 8

Review of Related Research 8
Textbook Sample 15
Definitions 18
Identification of Illustrations 24
Illustration Sample 30
Units of Analysis 33

IV. PHYSICAL TYPE TAXONOMY 37

Introduction 37
Physical Scale 1: Area 41
Physical Scale 2: Framing 43
Physical Scale 3: Configuration 45
Physical Scale 4: Position 46
Physical Scale 5: Elements: Pictorial, Verbal, Design . 49
Physical Scale 6: Color (Chroma) 51
Physical Scale 7: Non-Color (Achroma) 54
Physical Scale 8: Encoding Medium 56
Physical Scale 9: Encoding Style 58
Physical Scale 10: Information Level 60
Physical Scale 11: Unification/Separation 63
Possible Other Scales 65
Judging Procedures 69

V. OBJECTIVE TYPE TAXONOMY 71

Introduction 71
Pretest of Objective Taxonomy 73
Refined Objective Taxonomy 78
Level of Involvement Scale 88
Judging Procedures 90
Scaling Objective Data 100

VI. VERBAL MODIFIER TAXONOMY 104

Definitions 104
Sentence Scales 107
Non-sentence Scales 109
Other Possible Scales 110
Judging Procedures 112

Chapter Page

VII. RESULTS 116

Introduction 116
Analyses of Subject Matter by Objective Type 127
Analyses of Subject Matter by Physical Type 136
Analyses of Subject Matter by Verbal Modifier Type 156
Analyses of Objective Types by Physical Types 168
Analyses of Objective Types by Verbal Modifier Types . . . 237

VIII. DISCUSSION 275

IX. CONCLUSIONS AND RECOMMENDATIONS 290

Conclusions 290
Recommendations 293

BIBLIOGRAPHY 297

SUMMARY 299

Problem 299
Objectives 299
Methods 300
Results 308
Conclusions 315
Recommendations and Implications 317

Appendix A: States Supplying Textbook Adoption Data . . . 319
Appendix B: Textbooks in Sample 320
Appendix C: Publishers in Sample 323
Appendix D: Procedure for Identifying Illustrations . . . 324
Appendix E: Illustration Sample 326
Appendix F: Taxonomy of Physical Properties of Instructional Illustrations 336
Appendix G: Teachers and School Systems Participating . . 337
Appendix H: Objective Taxonomy 338
Appendix I: Educational Objectives 354
Appendix J: Procedure for Identifying Verbal Modifiers . 406

CHAPTER I

INTRODUCTION

Amid all the furor over the new trends in educational technology, the commonplace print media remain largely unchallenged as the most widely used educational resources of all. Great advances have been made in the art and science of printing, but their educational significance is rather less apparent. For example, it is almost indisputable that the lavish use of illustrations makes modern textbooks more attractive, and some research with younger children supports this view. However, the case for older learners is much less well-established, and one wonders what essential educational role the illustrations serve in many of the current printed materials. Illustrations certainly add to the size and cost of books, but what evidence is there that they add proportionately to learning?

Preliminary to the systematic investigation of learning as a function of instructional illustrations, there must be an objective delineation of the several potentially criterial characteristics of illustrations, such as the physical attributes of the pictorial elements, the attributes of the associated verbal elements, the educational objectives they might serve, and the subject matter with which they deal. A reliable taxonomy of each of these potentially criterial attributes would be needed before a systematic appraisal could be made of illustrations as they presently occur in textbooks. Further, such a taxonomy would be necessary to the adequate specification of variables in an experimental study of illustrations, particularly if such a study were to depart from the practice of treating pictures as a unitary and undifferentiated class of stimuli.

Thus, several typologies would seem to be essential both to an initial survey of the characteristics of existing textbook illustrations and to the eventual study of their educational significance, i.e., their effect on learning. An ultimate goal would be the discovery of predictive criteria by which designers of textbooks, self-instructional programs, and eventual instructional systems could optimally match the characteristics of illustrations to the other components (man or machine or materials) which together would function with maximum efficiency and effectiveness to meet predetermined educational goals.

CHAPTER II

OBJECTIVES

The objectives of this study were both immediate and long range. There were four immediate objectives.

1. Design taxonomies of instructional illustrations that would include physical types (pictures), verbal modifier types (captions, etc.), educational objective types, and subject-matter types.
2. Test and refine the taxonomies with reference to a sample of textbook illustrations.
3. Perform a systematic analysis of a sample of textbook illustrations by tabulating frequencies of occurrence of each type and by assessing the significance of the associations between types.
4. Generate preliminary research questions regarding relations between the characteristics of illustrations and the associated learning by students.

There were several long-range objectives.

1. Provide an initial delineation of the characteristics of illustrations that would serve to stimulate interest in the generation of research hypotheses about pictorial stimuli.
2. Enable researchers to be more objective and consistent in their use of and description of pictorial stimuli, whether or not stimulus characteristics were the variables under examination.

3. Initiate a program of research about the relation of pictorial stimulus variables to perception and learning.
4. Provide an initial step in a program of research that would analyze in depth the learner-textbook transaction, with particular reference to illustrations.

The four taxonomies (physical type, verbal modifier type, objective type, and subject-matter type) received differing amounts of attention in this study. The physical type taxonomy was one of the two primary foci of this study, because of its judged potential for future research and because of the dearth of such taxonomic efforts to date.

The primary objective of the physical type taxonomy was to develop a system for classifying pictorial stimuli that would be of value both to researchers and practitioners. It was intended that this taxonomy would suggest researchable factors for interested investigators and assist the researcher in the specification and control of the physical characteristics of his stimuli. It was planned also that the textbook author, editor, or artist, or the teacher, librarian, or audio-visual person might find the taxonomy a basis for describing and comparing educational materials. The development of a physical type taxonomy is described in Chapter IV.

The second most thoroughly delineated taxonomy was that of objective type. The rationale for this taxonomy was simply that any assessment of instructional materials must ultimately be made with reference to instructional objectives. This rationale had immediate relevance to the limited present study and potential relevance to more definitive future studies. While there has been considerable work done in recent years in classifying objectives, Bloom (2), Gagne (4), there has also been considerable adaptation of these taxonomies to meet particular instructional or research requirements. For the purposes of this study, it was found necessary to adapt Bloom's taxonomies and to incorporate some of Mager's (11) criteria for behavioral objectives. The intent was to develop an educational objective taxonomy that could be applied by teachers to the writing of objectives for given illustrations. The development of an objective type taxonomy is described in Chapter V.

The verbal modifier taxonomy (captions, titles, labels) was judged important because most pictures in the textbooks studied were accompanied by verbal material, and, in fact, appeared upon close examination to be educationally inseparable from the verbal material. The verbal modifier taxonomy was a modest effort in this study. It by no means exhausted the possibilities, nor was it indicative of the judged educational importance of the verbal aspects of illustrations in comparison to the importance of the pictorial. The verbal modifier taxonomy was largely syntactic in character rather than semantic because of the greater objectivity associated with the former. It relied heavily upon existing definitions, such as that for a "sentence." The development of a verbal modifier taxonomy is described in Chapter VI.

The fourth and final taxonomy was that for subject matter types. The minimum effort given this taxonomy in this study is not indicative of its judged importance to eventual research about the educational utility of textbook illustrations. It appeared that an adequate taxonomy of subject matter should surmount the topical categories around which present textbooks are organized, and instead should utilize the more basic "structures" associated with each area of knowledge. However, although "knowledge structures" are currently being actively conceived and debated by academicians, there is insufficient consensus at this time to permit extensive application of such structures or "ways of knowing" to illustrations.

Examination of textbooks prior to this study suggested that illustration types would probably be associated with subject-matter types. The four subject-matter areas included in the study (English, history, mathematics, and science) were chosen as representative of the general body of subject matter in the public school curriculum and were judged to be sufficiently diverse for comparative purposes. The four subject areas constituted the four categories in the subject-matter taxonomy.

The application of the four taxonomies to a sample of approximately 800 textbook illustrations yielded frequency data for 231 Chi-Square tests of independence. Given most attention in the report were the analyses of relationships between the following: subject-matter types and objective types, subject-matter types and physical types, subject-matter types and verbal modifier types, objective types and physical types, objective types and verbal modifier types. The contingency tables for these analyses are given in Chapter VII, Results.

In sum, the intent of this study was:

1. the construction of four taxonomies (physical type, objective type, verbal modifier type and subject-matter type) for classifying textbook illustrations;

2. the application of the taxonomies to the preliminary study of illustrations as they occur in textbooks at the eighth-grade level in four subject-matter areas; and

3. the generation of preliminary questions for experimental research relating the four taxonomies of instructional illustrations to the perceptions and learnings of students.

CHAPTER III

INITIAL PROCEDURES

This chapter presents an overview of the conceptualization, definition, and sampling process that preceded construction of the four taxonomies (physical, objective, verbal modifier, subject-matter). The detailed procedure for three of the four taxonomies follows in Chapters IV through VI respectively (the fourth taxonomy, subject matter, does not require elaboration, as indicated in the previous chapter).

Review of Related Research

The breadth of such reviews is typically a function of the writer's interpretation of the three criterial terms. What material is "related," what of that qualifies as "research," and how complete shall be the "review" of the selected studies? In the present situation the most selective criterion is the first: What is related?

Based on systematic searches, both before this study and after, the writer must make the assertion that only one study is related to the objectives outlined in Chapter II. That study is, "Requirements for Graphic Teaching Machines," by Hickey and others (6). No other study was found which attempts a comparable taxonomy of textbook illustrations or a statistical analysis of the frequencies or percentages of classes of textbook illustrations across subject matters. One aspect of the present study, the objective taxonomy, was related to several other studies, and a discussion of this relationship is given in the introduction to Chapter V, Objective Type Taxonomy.

Before consideration of the one related study, further clarification of the writer's interpretation of "related" may be warranted. No study was considered related if it was an experimental study of the effects (cognitive, affective, psychomotor, physiological, or other) of pictures or illustrations. This eliminated 57 studies done before 1952, as listed in a review (19), and an uncounted number done since. The lack of relatedness of these studies to the present one is as follows: they are experimental while this is descriptive; they deal with the effects of illustrations while this deals with the classification of illustrations; they relate attributes of illustrations to behavior while this relates attributes to attributes; they are narrowly concerned with a selected few attributes of illustrations while this is broadly concerned with the range of possible attributes.

There is, in sum, insufficient common ground (relatedness) for meaningful comparisons between such studies and the present one. The appropriate occasion for relating the two will be when this investigator and others employ the taxonomies from this study in their conception of specific experimental studies or programs of research. Comparisons must then be made between the experimental research that is planned and the findings of the specifically related experimental research that has been done. In anticipation of such future developments, there has been presented with each taxonomy in this study several related questions that were judged to be researchable. These were intended to fulfill the research stimulation objective of the study.

Related study. One purpose of the study by Hickey (6), hereinafter called the Hickey study, was the design of a teaching device for the display of graphic stimuli in a self-instructional program. A necessary prerequisite to this was seen to be a taxonomic matrix of the graphic stimuli and graphic responses which could be found in existing media. The textbook was the medium chosen for study, specifically the algebra, biology, and music textbooks approved for high school use in Boston. Another purpose of the study was the use of the taxonomy as a framework for a number of experimental studies. The latter purpose is common to both the present study and the Hickey study.

One of the more apparent differences between the two studies was that of scope. The Hickey study included 17 books in three subjects while this study included 40 books in four subjects. The Hickey study isolated 30 stimulus categories, 23 of which could be called pictorial (in the sense of the present study) and seven of which could be called verbal-numerical. The present study isolated 107 pictorial stimulus categories and 48 verbal-numeric. Further, it appeared that each "graphic stimulus" in the Hickey study was placed in only one of the 30 categories, while in the present study each illustration was given 11 ratings as to its pictorial characteristics and five as to its verbal-numerical characteristics, or 16 in all.

Also differing were the stimuli classified. The Hickey study classified "graphic stimuli," which were defined as any presentation material that departed from narrative format or from the dominant format for the text. The present study focused exclusively on illustrations and their verbal modifiers, though the term illustration was broadly interpreted. The rationale for the attention to illustrations was that they consume a large amount of valuable page area, that they are pervasive in modern textbooks (an average of 1 every 1.58 pages in the sample), and that they have not even been thoroughly described let alone thoroughly evaluated or researched.

There is no counterpart in the present study for the survey of "graphic responses" in the Hickey study. The apparent source for the response data was selected end-of-chapter questions, though the graphic stimuli within the chapters were also examined for evidence of an associated response that was expected of the student. Responses were thus limited to those specified in situ by the textbook authors or editors.

The present study categorized each illustration in terms of the "most appropriate" educational objective, whether specified or implied in the book or added on the basis of experience by the practicing teachers who did the judging. The objectives were stated in terms of student behavior and in that sense corresponded with the Hickey survey of graphic responses.

The Hickey study was more detailed in its examination of response modes, listing 16 categories such as: draw a diagram, vocalize, attend to an emphasized objective, solve an equation. These tended to be quite specific to particular subject matter. The present study dealt with five broad types of behavior such as analysis, application, etc. Under each type were listed appropriate responses such as: to identify, to compare, to solve, to state, etc., the object of such action being specific to the subject matter but not further categorized.

The statistical treatment of the Hickey data was a profile analysis which revealed significant differences ($p < .01$) between the profiles of graphic stimuli and responses for the three subjects. The statistical product of the present study was 231 Chi-Square tests of independence of which about one third are discussed in this report.

In short, it was the initial intent of the present study to pursue the taxonomic problem in somewhat greater depth and breadth than did the Hickey study. It does appear that there were important differences between the two studies in intent, scope, method, definition of the stimuli and responses studied, taxonomic systems and categories, statistical methods and findings. The latter differences will be elaborated to greater degree in Chapter VII, Results.

Other studies. Three other studies of pictorial materials will be mentioned here. Although these have taxonomic implications, they are quite different in method and intent from the present study.

Gropper (5) has classified non-verbal visuals according to their function in the process of achieving stimulus control over learner responses.

1. Visuals as Cues and Reinforcers
    - A. Intermediate Visuals--desired response already under their control (or can readily be brought under) so that the response can be cued and control of it transferred to another stimulus.
    - B. Criterion Visuals--final response to be brought under their control.
2. Visuals as Examples
    - A. Intermediate Visuals
    - B. Criterion Visuals

Such functional classes of visuals, while conceived in terms of the programmer or designer of instructional materials, are based on learner behavior. This behavioral orientation is an important contribution, for the ultimate test of an instructional illustration is the behavior it elicits. Gropper's functional classes provide few guidelines for the production or selection of such visuals, but they do prescribe the role of the visuals in instruction and hence a basis for determining when and if the appropriate ones have been found. Suppose that a need were demonstrated for an intermediate visual of a certain subject to serve as a cue. The next questions to ask would be such as these: what behavioral probabilities are attached (for a given type of learner) to such alternatives as color vs. black and white, realistic photograph vs. diagrammatic drawing, one column size vs. four column, etc.? The present study yielded some related information, namely, the probable choices of illustration types that book designers and authors would make to achieve comparable objectives, but there is no evidence as to what the behavioral consequences of these choices would be.

There is some relationship between the objectives written for illustrations in the present study and Gropper's functional classes. An illustration judged to be appropriate for an analysis objective, for example, would presumably function adequately as a cue for the student's analytical behavior.

Knowlton (7) reports the beginning of a taxonomy of visual-iconic signs which is independent of the physical attributes of the sign vehicles, i.e., textbook illustrations for example. Visual-iconic representations are conceived as having three "parts": elements, their pattern of arrangement, and their order of connection. Each such "part" can represent in any one of three ways: realistically, analogically, or arbitrarily. From the possible combinations of "parts" of representations and ways of representing there results a taxonomy of 27 possible types of visual-iconic representation. This taxonomy should provide a productive framework for important research.

While being relatively independent of physical attributes such as those categorized in the present study, the Knowlton taxonomy is judged by this writer to be physicalistic in the sense that elements, as well as the other parts of a representation, are physical components or attributes of that representation. Similarly, the ways of representing (realistic, analogical, and logical) imply, to greater or lesser degree, the presence or absence of certain types of physical characteristics. Thus, if an instructional situation required an intermediate visual, a la Gropper, further specification of it would be possible under the Knowlton framework, i.e., it could be specified as having elements that are realistic and a pattern of those elements that is analogical. This would greatly reduce the number of alternative forms the representation might take and would thus facilitate the design of an appropriate illustration.

Rouse (15) has developed a descriptive scale for assessing art products. The scale as presently refined yielded satisfactory interrater agreement scores (.61 to .91) when applied to 50 art products. The 20-item scale was factor analyzed and found to consist of six domains. Ratings of art objects using one of these domains (Internal Static/Dynamic Action) were found by t-test to be significantly related ($p < .05$) to independent expert ratings of "best" and "poorest" of the same art objects. An implication for the present study would be the possibility of rating or classifying instructional illustrations (particularly those having an appreciation objective) from an artistic point of view.

It appears to this writer that these studies, while markedly different, may together with the Hickey study and the present study suggest the beginnings of a more rigorous and comprehensive attack on the pictorial domain. The mechanistic behavioral approach of Gropper, the visual-iconic taxonomy of Knowlton, and the artistic criteria of Rouse could in concert begin to describe an appropriate illustration for a particular instructional situation, while the taxonomies of the present study and the Hickey study could provide a framework for further physical specification of that illustration.

Textbook Sample

The first sampling step was the choice of the textbooks to be examined. The initial plan was to examine 16 to 20 books, but this number was expanded to 40 so that the findings would be more representative.

It was judged necessary to limit the sample to books at one grade level, particularly for an initial study. The eighth grade level was chosen because it is the approximate midpoint of the first grade through college senior range. A preliminary examination of books across the sixteen-year range revealed that some 8th grade books appeared much like grade 4-6 books in style and frequency of illustration, while others appeared much like grade 9-12 books. Thus, the sample of 8th grade texts, while ostensibly unitary in level, did include desirable diversity in the types of illustrations.

It was apparent from the examination of 8th grade textbooks that many of the differences in characteristics of illustrations were associated with differences in subject matter (maps in history, geometric figures in mathematics, etc.). Consequently, four different subject-matter areas (English, American history, mathematics, and science) were selected to represent a range of illustration types.

In sum, there were 40 textbooks in the sample, 10 from each of four subject areas at the eighth grade level. Workbooks, lab manuals and other auxiliary or resource books were omitted. In English, language texts were chosen instead of literature. Several programed texts from each subject area were examined but proved to be so idiosyncratic as to be not readily admissible into the sample. Many had no illustrations whatever.

According to Textbooks in Print 1965 (17), there were 29 publishers in the United States offering textbooks at the eighth grade level in one or more of the four subject areas. Of these, 12 offered one or more books in language (composition and grammer); 19 offered one or more in American history; 15, one or more in arithmetic; and 13, one or more in general science.

The intent in drawing a sample of the available textbooks was to choose the 10 most widely sold or used in each subject area. Sales and use data being unavailable, the criterion used was frequency of state adoption. Adoption lists were requested from the 27 states in which a state agency (in contrast to a local unit) selected one or more books in one or more subject areas for use at the eighth grade level. Adoption lists were received from 22 states. (See Appendix A.) The tabulation of these by title, author, publisher, and copyright date produced a list of 27 English books, 50 American history books, 52 mathematics books, and 51 science books, or a total of 180.

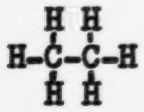
Examination of the 180-book population revealed that few had been adopted widely enough to be chosen. However, because of the extensive overlap of authors, titles, and publishers, an attempt was made to establish a basis for pooling the data. Of the several possible bases, pooling by publisher produced the most orderly tabulation. Consequently, the ten publishers occurring most frequently were chosen for each subject area. Still remaining was the selection of one book from the several editions and series offered by a chosen publisher. This selection was resolved by choosing the edition with the most recent copyright date. The purchase order simply read, "basic eighth grade science textbook," and, in case of two or more, "the one with most recent copyright." No titles or authors were specified, much to the consternation of some publishers.

In sum, the sample for each subject area consisted of the most recent edition from the ten publishers whose 8th grade textbook(s) were most frequently adopted by the 22 states reporting adoptions. In effect, the edition chosen was, in many cases, actually too new to have been widely adopted, but was a revision, usually by the same authors, of a book that in earlier editions had been widely adopted. In such cases it seems likely that the edition chosen for study will in time be widely adopted. However, there was also the possibility, particularly in rapidly changing curricular areas such as mathematics and science, that the text chosen was not a revision of a previously popular edition but an altogether new book with different authors and content. Such a book may not prove to be as widely adopted as the publisher's earlier efforts with a standard curriculum and tested authors.

Assuming that the books adopted by the 22 reporting state agencies do not differ systematically either from those adopted by the five states not reporting or from the adoptions by local agencies in the remaining 23 states, the sample accurately represents the newest textbooks of the most frequently adopted publishers.

The sample included from 48 per cent (history) to 71 per cent (English) of the publishers on the reported state adoption lists for the eighth-grade level. The 40 book sample included 17 publishers, four of whom had one book in the sample, six of whom had two books, four of whom had three books, and three of whom had four books. A list of the books is in Appendix B, and a list of the publishers is in Appendix C.

Definitions

An unexpectedly complex task for this study was the operational definition of "illustration." It had been anticipated that both pictorial and verbal elements would be included, but even the distinction between pictorial and verbal appeared to be clouded. For example, is a number line in mathematics pictorial or verbal? At what point does a picture of a typed business letter become indistinguishable from an all-verbal printed page? Is the chemical structural formula  $\mathrm{H-\overset{H}{\underset{H}{C}}-\overset{H}{\underset{H}{C}}-H}$ pictorial or verbal? Are charts, graphs, and tables pictorial, particularly when they consist primarily of verbal material? Are arrows pictorial or design elements?

Although some "grays" remained, definitions were made to answer some of the above questions as follows:

Pictorial elements. Those configurations of line, dot, or area and any combination of these three that resemble events or objects (persons, places, and/or things), either as perceived or as generally conceived. Included were the following border-line cases: number lines and geometric figures commonly found in mathematics textbooks; structural formulae in chemistry; curves, graphs, and time lines commonly found in history and science textbooks.

Verbal elements. Those configurations of line, dot, or area and any combination of these three that resemble alphabetical or numerical symbols. Included were pictorial lettering, punctuation marks, and musical and scientific notations so long as they were arbitrary, i.e., did not resemble objects or events. Tables were generally included unless they resembled common objects, such as train timetables.

Design elements. Those configurations of line, dot, or area that did not meet the definition of either pictorial or verbal elements. Those configurations that occur most frequently in textbooks seem to modify or direct attention toward pictorial or verbal elements. Examples were lines around or between areas; arrows; check marks, spheres, stars, etc. at the beginning of paragraphs; and colored or textured areas under pictorial or verbal elements.

It may be useful to relate these definitions to an array of assorted elements, such as Figure 1. What does each element resemble? Some are "obvious" resemblances but others are ambiguous. With reference to the latter, classification as verbal or pictorial or design may be an individual matter and may change with time. If one of the circular configurations appears to be a capital "O" and the observer so labels it, then operationally it "is" a verbal element. If it appears as a wheel or life-saver or plate and the observer so identifies it, then behaviorally it "is" a pictorial element. If neither, it would be classified as a design element.

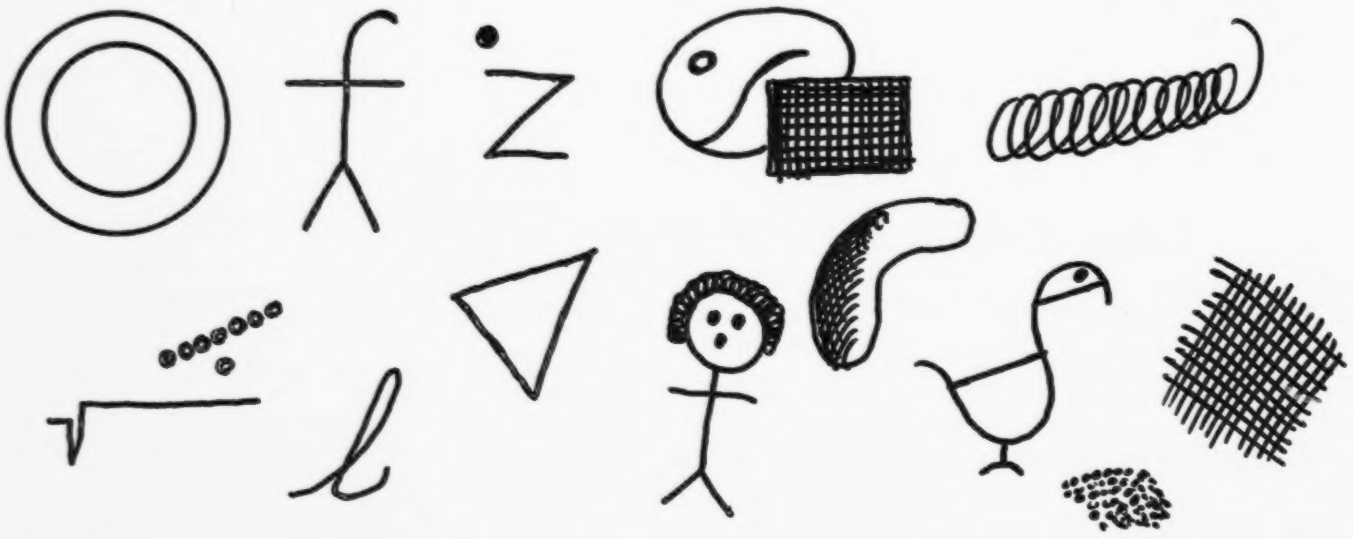


Figure 1. Array of Elements: Pictorial, Verbal, Design

As can be seen, each definition stated a few specific types of elements or configurations that were otherwise potentially ambiguous as to classification. These assignments of ambiguous elements or configurations to specific categories were admittedly arbitrary but nonetheless necessary to reliable objective categorization. The ambiguous cases tended to be those in which the elements resembled in part objects and events and in part alphabetical-numerical symbols. In some cases for example, the resemblance to objects was only quantitative, such as the length of a bar graph being proportional to (resembling) the amount of wheat grown. In other cases, the resemblance to events was only temporal, such as the length of a time line being proportional to (resembling) the length of time between two historical events.

The phrase "or generally conceived" in the definition of pictorial elements refers to the case wherein modern man has not perceived the object or event but has a conception of it which he represents with pictorial elements. Examples might be prehistoric animals, subatomic particles, or God.

It should be noted that the dictionary definitions of picture, illustration, chart, table, graph, caption, label, etc., that might have proved definitive, were in practice of little value, partly because there was extensive overlap between definitions and partly because the sample of illustrations included glaring exceptions to all definitions. Consequently, compromises were necessary and the modus operandi was in the direction of objectivity rather than in correspondence to general usage of the terms.

In devising a procedure for identifying "illustration," it was necessary to begin with a readily isolable unit, the textbook page, and to dissect it into its component parts, one of which would be an illustration.

Visual Unit. The page, i.e., a flat surface which is bounded on one side by the spine of the book and on the other three sides by the trimmed edges.

Area. Major division of the visual unit which is perceived to be separate or distinct from other areas of the page. See Figure 2. This separateness can be ascribed to one or more of the following:

1. isolation of the area by frames, edges and margins--such as the white margins bordering columns of print and separating print from picture;
2. proximity or close grouping of elements within the area;
3. similarity of elements within the area, such as a predominance of pictorial elements or of verbal elements.

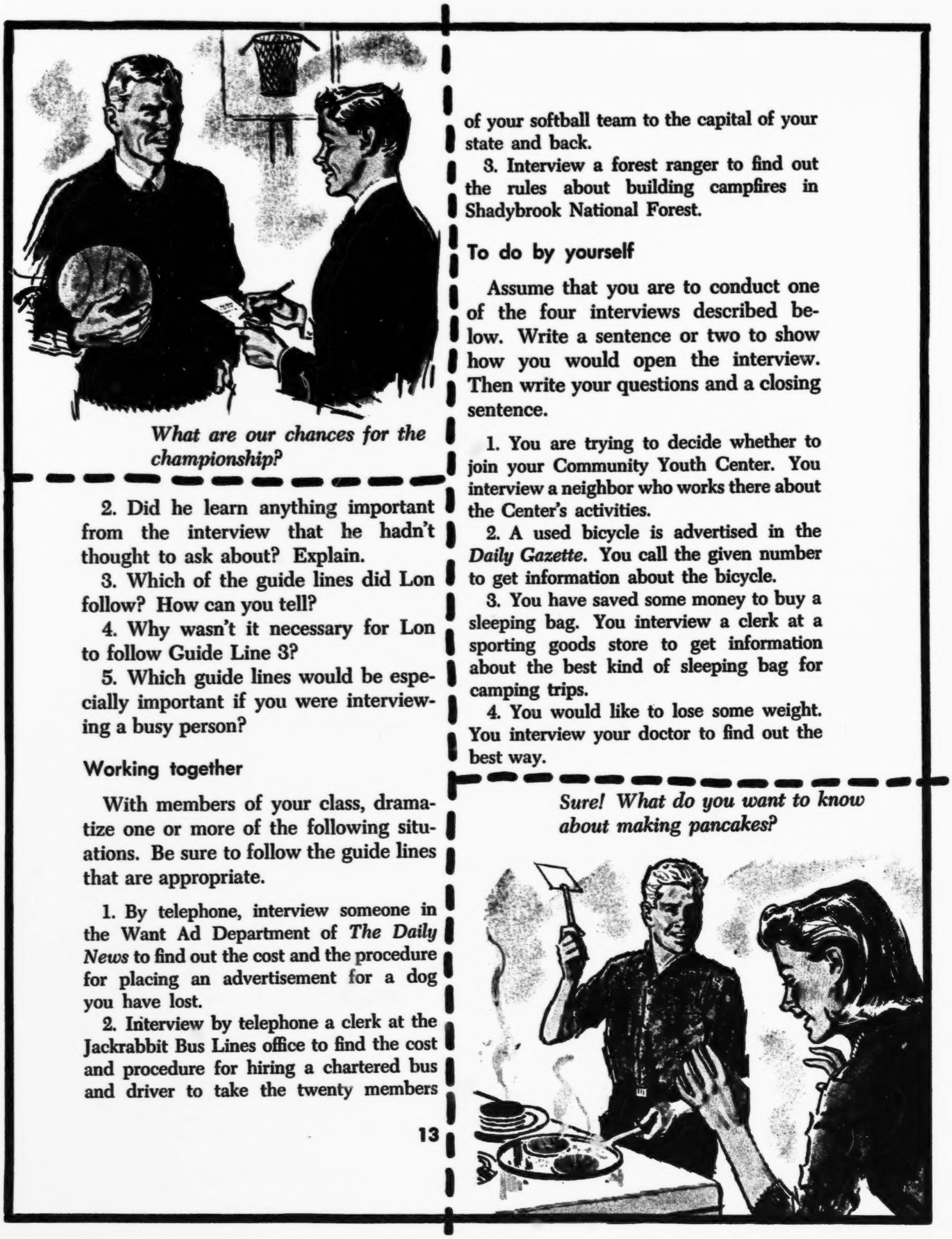
Pictorial Area. Any area including pictorial elements. (See Figure 2.) It could also include associated verbal and/or design elements. A pictorial area could occasionally be composed of discriminable sub-units called pictorial units. These will be further explicated in Chapter IV, Physical Type Taxonomy.

Verbal Area. An area including verbal elements. (See Figure 2.) It could also include associated design elements but could not include pictorial elements. A verbal area could be composed of one or more discriminable sub-units called verbal units. Verbal units will be further explicated in Chapter VI, Verbal Modifier Taxonomy.

From these considerations an equation was devised for a visual unit or page as follows: Visual Unit = $A_p + A_v$

where A_p is pictorial area(s), if any

A_v is verbal area(s), if any



What are our chances for the championship?

2. Did he learn anything important from the interview that he hadn't thought to ask about? Explain.
3. Which of the guide lines did Lon follow? How can you tell?
4. Why wasn't it necessary for Lon to follow Guide Line 3?
5. Which guide lines would be especially important if you were interviewing a busy person?

Working together

With members of your class, dramatize one or more of the following situations. Be sure to follow the guide lines that are appropriate.

1. By telephone, interview someone in the Want Ad Department of *The Daily News* to find out the cost and the procedure for placing an advertisement for a dog you have lost.
2. Interview by telephone a clerk at the Jackrabbit Bus Lines office to find the cost and procedure for hiring a chartered bus and driver to take the twenty members of your softball team to the capital of your state and back.
3. Interview a forest ranger to find out the rules about building campfires in Shadybrook National Forest.

To do by yourself

Assume that you are to conduct one of the four interviews described below. Write a sentence or two to show how you would open the interview. Then write your questions and a closing sentence.

1. You are trying to decide whether to join your Community Youth Center. You interview a neighbor who works there about the Center's activities.
2. A used bicycle is advertised in the *Daily Gazette*. You call the given number to get information about the bicycle.
3. You have saved some money to buy a sleeping bag. You interview a clerk at a sporting goods store to get information about the best kind of sleeping bag for camping trips.
4. You would like to lose some weight. You interview your doctor to find out the best way.

Sure! What do you want to know about making pancakes?

13

Figure 2. Page Divided Into Four Areas - Two Pictorial, Two Verbal

(From English For Meaning 8 by McKee, Prestwood, Blossom, Watson, and Floyd. Copyright 1962, 1960 by Houghton Mifflin Company and used by permission of the publishers.)

Further analysis based on prior definitions yields the following two equations: 1. $A_p = p + (v) + (d)$

where p is pictorial element(s)

(v) is verbal element(s), if any

(d) is design element(s), if any

2. $A_v = v + (d)$

where v is verbal element(s)

(d) is design element(s), if any

The above formulations underlie all others to follow and provide the starting point for defining the term "illustration."

Identification of Illustrations

The specific procedure for identifying an illustration, the basic unit of analysis, is given in Appendix D and may appear rather complex. In general, two types of criteria were used: perceptual (layout of elements on a page) and instructional (function of the elements). The three principal defining steps follow.

1. All pages containing only verbal elements (or with design elements) were eliminated from consideration; conversely, all pages containing only pictorial elements (or with design elements) were considered to be illustrations.

2. The pages with mixtures of pictorial and verbal elements were divided into areas by drawing an imaginary line between the isolable areas on the page. See Figure 2. Areas containing any pictorial elements were considered pictorial areas, and areas containing

only verbal elements were verbal areas. (Captions were always found to be associated with pictures and were thus considered a part of pictorial areas.)

3. All the pictorial areas so isolated were considered to be illustrations with the following exceptions:

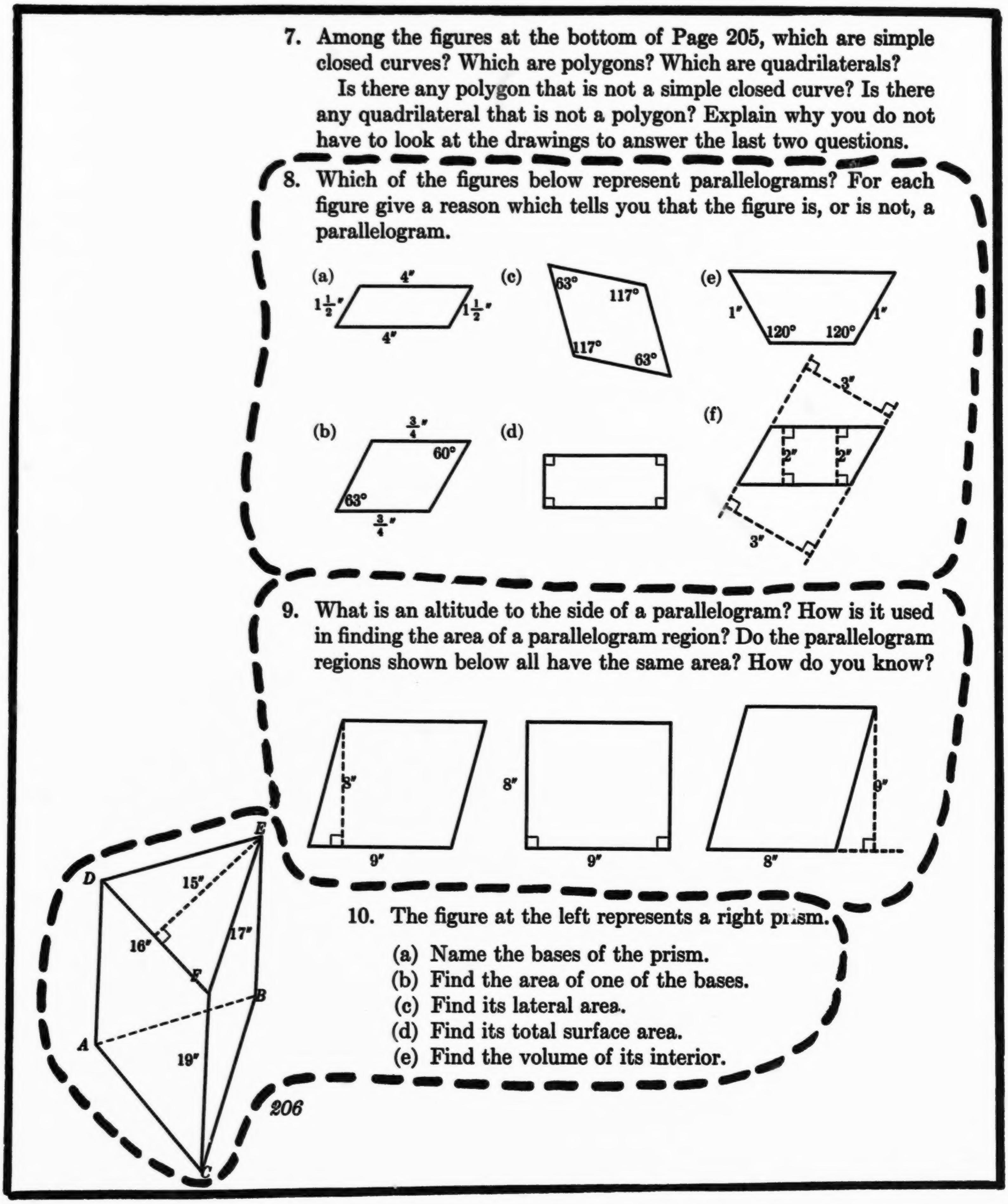
a. All pictorial areas that are a part of an isolable exercise, experiment, question, or problem were combined with the verbal elements of the exercise, experiment, question, or problem to comprise an illustration. See Figure 3.

b. All pictorial areas containing two or more captions were divided correspondingly into two or more illustrations unless the areas were instructionally unified, i.e.,

a sequence or series, such as a procedure or process
a comparison or change with time
an enumeration or group of examples. See Figure 4.

Step 1 required only the identification of all verbal and all pictorial pages.

Step 2 was dependent on the layout of the page which quite reliably puts white space between areas or lines around them. This white space can be seen as basically dependent on perceptual criteria, i.e., elements that were closest to each other (proximity) and contained similar elements (similarity) were perceptually organized together as areas. Each such area was separate and different from the other areas (contrast) and could be perceptually discriminated from the others.



7. Among the figures at the bottom of Page 205, which are simple closed curves? Which are polygons? Which are quadrilaterals?
   Is there any polygon that is not a simple closed curve? Is there any quadrilateral that is not a polygon? Explain why you do not have to look at the drawings to answer the last two questions.

8. Which of the figures below represent parallelograms? For each figure give a reason which tells you that the figure is, or is not, a parallelogram.

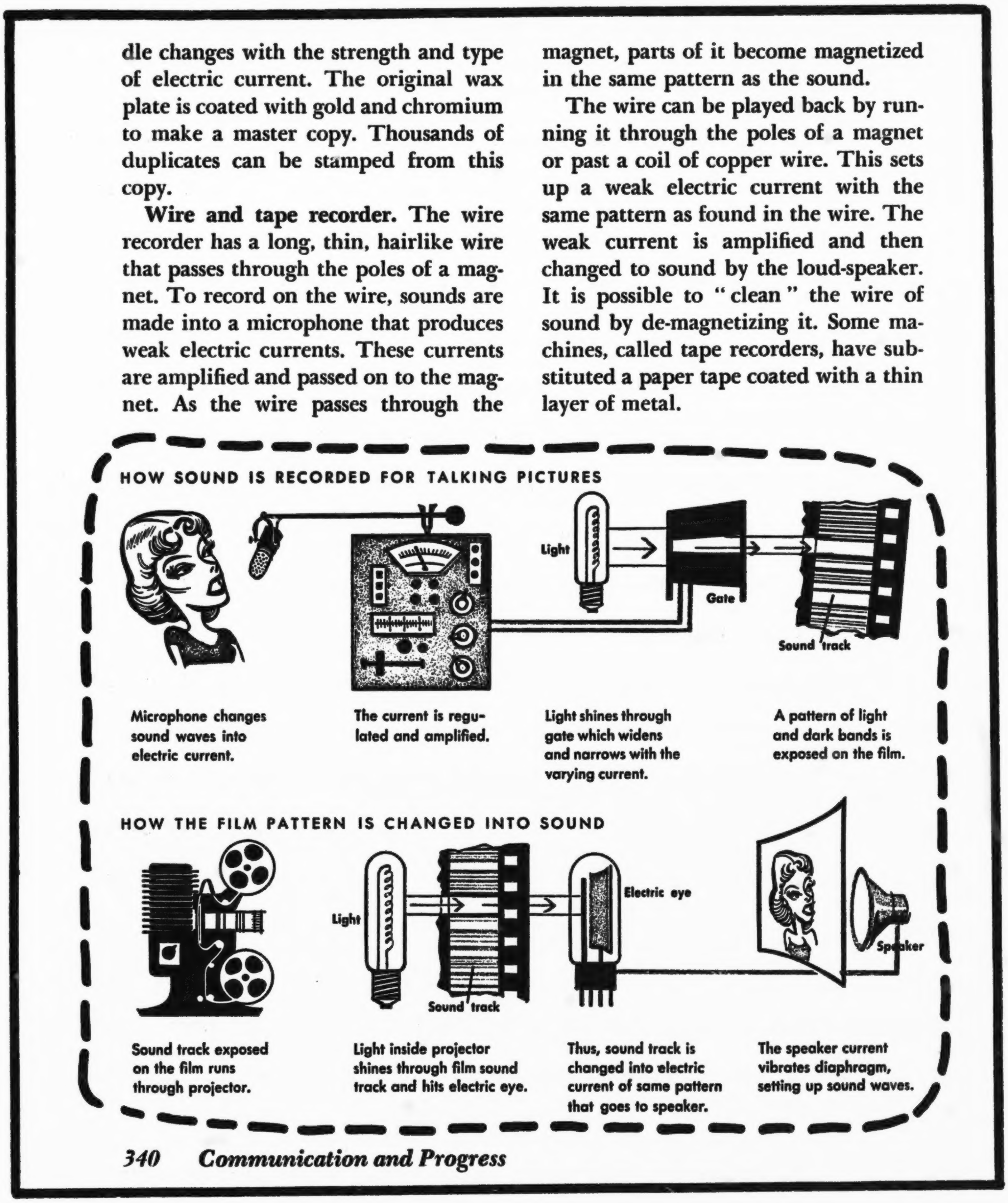
9. What is an altitude to the side of a parallelogram? How is it used in finding the area of a parallelogram region? Do the parallelogram regions shown below all have the same area? How do you know?

10. The figure at the left represents a right prism.
    (a) Name the bases of the prism.
    (b) Find the area of one of the bases.
    (c) Find its lateral area.
    (d) Find its total surface area.
    (e) Find the volume of its interior.

206

Figure 3. Illustrations Which Combine the Pictorial and Verbal Areas of a Problem or Question

(From Introduction to Secondary Mathematics 1965 edition, by Haag and Dudley. Copyrighted. Used by permission of publishers, D. C. Heath and Company.)



dle changes with the strength and type of electric current. The original wax plate is coated with gold and chromium to make a master copy. Thousands of duplicates can be stamped from this copy.

Wire and tape recorder. The wire recorder has a long, thin, hairlike wire that passes through the poles of a magnet. To record on the wire, sounds are made into a microphone that produces weak electric currents. These currents are amplified and passed on to the magnet. As the wire passes through the magnet, parts of it become magnetized in the same pattern as the sound.

The wire can be played back by running it through the poles of a magnet or past a coil of copper wire. This sets up a weak electric current with the same pattern as found in the wire. The weak current is amplified and then changed to sound by the loud-speaker. It is possible to "clean" the wire of sound by de-magnetizing it. Some machines, called tape recorders, have substituted a paper tape coated with a thin layer of metal.

HOW SOUND IS RECORDED FOR TALKING PICTURES

Microphone changes sound waves into electric current.

The current is regulated and amplified.

Light shines through gate which widens and narrows with the varying current.

A pattern of light and dark bands is exposed on the film.

HOW THE FILM PATTERN IS CHANGED INTO SOUND

Sound track exposed on the film runs through projector.

Light inside projector shines through film sound track and hits electric eye.

Thus, sound track is changed into electric current of same pattern that goes to speaker.

The speaker current vibrates diaphragm, setting up sound waves.

340 Communication and Progress

Figure 4. Instructionally Unified Illustration Composed of Isolable and Separately Captioned Pictorial Areas

(From Broadening Worlds of Science by Jacobson, King, Killie, and Konicek. Copyrighted. Reproduced by permission of publishers, American Book Company.)

Step 3 was more dependent on instructional function. It was considered that the verbal statement of a geometry problem should not be arbitrarily separated from the geometric figure with which it is inextricably associated, although perceptually the pictorial and verbal parts of the problem can be readily discriminable. Similarly, it was considered that the readily discriminable parts of a multiple-caption and multiple-picture area should be combined as one illustration if they functioned as an instructional unit. Some subjectivity occasionally entered here, but consideration of instructional unity was judged necessary in view of the eventual purpose of assigning educational objectives to each area defined as an illustration.

It follows from the above procedure that the concept of pictorial area (A_p) which was defined earlier has now been refined to that of illustration. The two usually are but not always synonymous, as the procedure indicates. The term "pictorial area" is perceptually based while that of "illustration" permits instructional considerations as well. I (illustration) approximates A_p.

Illustration was defined as a pictorial area, except that the area was added to or subdivided under the following conditions:

1. If the addition of one or more other pictorial areas forms an isolable instructional unit, the whole is an illustration.

2. If the addition of one or more verbal areas completes an isolable experiment, question, problem, or exercise, the whole is an illustration.

3. If the subdivision of a pictorial area yields pictorial units which are separately captioned and do not with other units comprise an instructional unit, each unit is an illustration.

The concept of instructional unit could, with increasingly liberal interpretation, be applied to several pages, a chapter, or even a book. Operationally, the concept was, as previously indicated, limited to the following: a sequence or series such as a procedure or process, a comparison or change with time, and an enumeration or group of examples.

Problems in the delineation of illustrations were encountered primarily where perceptual and instructional criteria were in conflict. Artists on the research staff tended to favor perceptual factors, while teachers on the staff tended to favor instructional functions. While no reliability estimate of this part of the procedure was made, care was taken to minimize unreliability. The most apparent sources of divergence were the individual staff judges and the individual textbooks. Each book tended to have its characteristic pattern of arrangement for pictorial and verbal areas. Consequently, a common section (40-50 pages) from each textbook was judged independently by each of the four judges. They then compared their work and adjusted their criteria as necessary to achieve consensus. Illustrations for the balance of each book were identified by any one of the judges.

Two months of initial discussion between staff members was required before the above definitions and procedures began to emerge. During this phase an arbitrary sample of 300 pages from textbooks (books not used in the final study) was mounted on cardboards and hung in rows on the walls of the conference room. These mounted pages were constantly rearranged and regrouped as categorization systems were proposed, evaluated, rejected, and refined. After general consensus on definitions and procedures was reached, the staff divided into a picture taxonomy group and an objective and caption taxonomy group. The work of these two groups is further detailed in the respective chapters that follow.

Illustration Sample

The choice of a sample of illustrations from the 40 textbooks was random. The first step was to identify and enumerate all the illustrations in the population, using the operational definition of illustration previously described.

Frequencies of occurrence of illustrations in the population are shown by subject matter in Table 1. Note that the distribution across subject matter is disproportional, ranging from 11 per cent for English to 35 per cent for history. The range of numbers of illustrations per book varies from that in English (15 to 255 or a ratio of 1:17) to that in science (327 to 470 or a ratio of 1:1.4). Publishers appear to be much more consistent in the number of illustrations they place in science textbooks than they are in the number they place in English textbooks.

TABLE 1. DISTRIBUTION OF ILLUSTRATIONS IN THE POPULATION ACROSS BOOKS AND SUBJECT MATTERS

Subject	Illustrations in population	Percentage of population	Average per book	Range per book
English	1,461	11	146	15-255
History	4,515	35	452	275-671
Mathematics	3,121	24	312	189-567
Science	3,805	30	381	327-470

The rates of occurrence of illustrations shown in Table 2 were computed by dividing the total number of illustrations in the history texts, for example, by the total number of pages in history texts. It reveals that there was on the average from 0.32 illustration per page in the English books to 0.79 illustration per page in the science books. For the entire population of 40 textbooks, there was an average of 0.64 illustration per page. Stated another way, the over-all ratio of illustrations to pages was 1 to 1.58. For English books taken separately, the ratio of illustrations to pages was 1 to 3.08; for history, 1 to 1.57; for mathematics, 1 to 1.27; and for science, 1 to 1.26.

TABLE 2. RATES AND RATIOS OF OCCURRENCE OF ILLUSTRATIONS IN THE POPULATION

Subject	Pages in population	Illustrations in population	Rate-illustration per page	Ratio-illustrations to pages
English	4,506	1,461	0.32	1:3.08
History	7,081	4,515	0.64	1:1.57
Mathematics	3,976	3,121	0.78	1:1.27
Science	4,816	3,805	0.79	1:1.26
All subjects			0.64	1:1.58

The above is substantial empirical evidence to support the observation that, at least in numbers, illustrations are pervasive in the modern 8th grade textbook. It is a defensible point of view that a phenomenon which occurs on the average of every 1.58 pages in these 40 textbooks merits intensive experimental work.

A sample of about 800 illustrations (200 per subject) had been proposed as adequate for a preliminary survey. It was subsequently decided that the sample should be proportional to the population for each subject rather than an equal 200 for each. Consequently, a six per cent proportional random sample was taken of the population which yielded 787 illustrations distributed as shown in Table 3.

TABLE 3. DISTRIBUTION OF ILLUSTRATIONS IN SAMPLE ACROSS BOOKS AND SUBJECT MATTER

Subject	Illustrations in population	Illustrations in sample	Percentage of sample	Approximate average per book
English	1,461	95	12.1	10
History	4,515	278	35.3	28
Mathematics	3,121	184	23.4	18
Science	3,805	230	29.2	23
Total	12,902	787	100.0	

The 6 per cent sample was taken by stratum, stratum being defined as the largest subdivision in a book, which was usually identified in the Table of Contents as a Unit. Although this resulted in a slightly larger than 6 per cent sample over-all, (larger by 13 illustrations), it had the merit of assuring that each major topical area in each book was sampled. (A list of illustrations in the sample by book and page is given in Appendix E.)

Two restrictions were placed on the sampling procedure. First, illustrations could not be drawn from opposite sides of one page (i.e., back-to-back), because pages were to be removed from the books and mounted. When back-to-back illustrations were drawn, the second one was dropped and another drawn to replace it. The second restriction was that duplicate illustrations would be eliminated when noted. Duplicate illustrations occurred primarily in one text where a particular illustration introduced the exercise section at the end of each chapter. Occasional adjacent strata yielding too few illustrations (less than 0.5 illustration at 6 per cent) were pooled.

The 787 illustrations can thus be said to be a representative sample of the population of illustrations occurring in the 40 eighth grade textbooks.

Units of Analysis

For three of the taxonomies (descriptions of which follow in Chapters IV-VI), the concept "illustration" was further dissected in ways that may seem esoteric. These ways are difficult to represent by equation, which will shortly be demonstrated. They are least abstrusely represented by example, Figures 5 to 7. For purposes of simplification, design elements, being non-criterial, will be omitted from the discussion.

$$I = U_p + U_v$$

where I = Illustration

U_p = Pictorial Unit

U_v = Verbal Unit

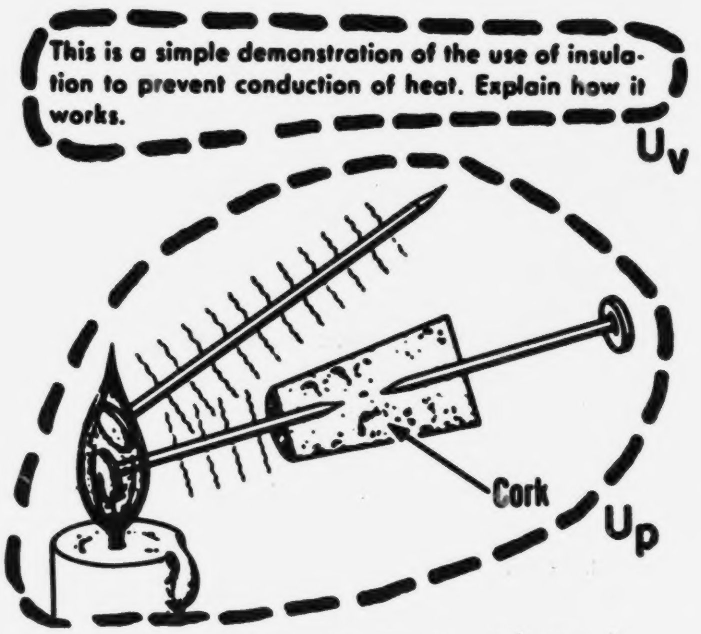

This is a simple demonstration of the use of insulation to prevent conduction of heat. Explain how it works.
U_v
Cork
U_p

Figure 5. Unit of Analysis for Objective Type Taxonomy (Pictorial Unit and Verbal Unit Together, i.e. the Illustration)

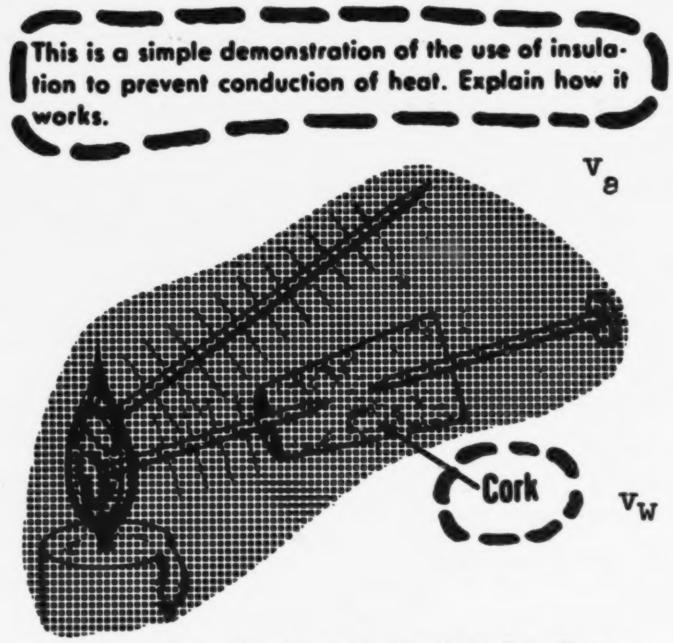

This is a simple demonstration of the use of insulation to prevent conduction of heat. Explain how it works.
v_e
Cork
v_w

Figure 7. Unit of Analysis for Verbal Modifier Taxonomy (Verbal Elements Within and Adjacent) (From Understanding Science for the Space Age, 1962 edition, by Victor C. Smith. Copyrighted. Used by permission of the Publishers, J. B. Lippincott Co.)

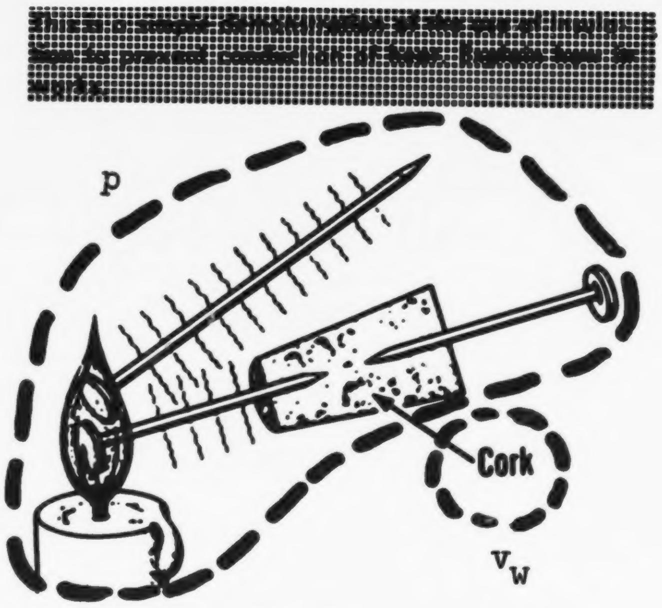


Figure 6. Unit of Analysis for Physical Type Taxonomy (Pictorial Elements and Verbal Elements Within)

Or, grossly, illustration equals pictorial unit (picture) plus adjacent verbal unit (caption). See Figure 5. Illustration, thus defined, was the unit of analysis for the Objective Taxonomy, Chapter V. Instructional criteria were predominant in this decision to include both the instructionally related components, picture and caption.

To distinguish between the provinces of the physical taxonomy and the verbal modifier taxonomy, U_p and U_v must be further analyzed.

$$U_p = p + v_w$$

$$U_v = v_a$$

where p is pictorial element(s) (see Figure 6)

v_w is verbal element(s) within the pictorial unit (see label in Figures 6 and 7)

v_a is verbal element(s) adjacent to the pictorial unit (see caption in Figure 7)

The pictorial unit (U_p), or picture, is the unit of analysis for the Physical Type Taxonomy, Chapter IV. Note, however, that, though called a pictorial unit, it includes both pictorial elements (p) and any verbal elements (v_w) which are within its area. (See Figure 6.) The verbal elements within U_p were included because they were an apparent physical component of U_p. In actuality, they were consistently determinative of physical category only for Scale 5, Elements. See Appendix F. Appropriately, perceptual criteria were predominant in the Physical Type Taxonomy.

Of the three types of elements, the Verbal Modifier Taxonomy deals with two (v_w and v_a), i.e., the verbal elements in the illustration whether they are within or adjacent to the pictorial unit. See Figure 7. Thus, the unit of analysis for the Verbal Modifier Taxonomy, explicated in Chapter VI, consists of all of the verbal elements which are part of the illustration. Generally included were captions, labels, and certain titles.

CHAPTER IV

PHYSICAL TYPE TAXONOMY

Introduction

It should be said that work on this taxonomy had the effect of strengthening the staff opinion that the pictorial domain approaches "infinity" in the number of discriminable variations it exhibits, at least potentially. This opinion is with regard to physical attributes only and disregards the immensity of the possible variations in what is pictured. In consequence of this diversity, eleven scales were developed with 107 sub-categories. These scales are in no sense all encompassing and are worth reporting primarily in the sense that no comparable effort is known to have been made. The limitations perceived by the staff are both in the range of types of physical scales and in the number of sub-categories (hereinafter referred to as points) into which each scale is subdivided.

Early in the delineation of scales, the range of types of physical scales reached 32. (See Table 4 for the names of these scales.) The 32 were reduced to eleven (first eleven in Table 4) by a prolonged group effort in which the primary considerations were reduction of overlap and reduction of subjectivity. Neither criterion was fully achieved.

TABLE 4. RANGE OF TYPES OF PHYSICAL SCALES CONSIDERED

Names of scales
1. Area
2. Framing
3. Shape
4. Position
5. Elements--Verbal, Pictorial, Design
6. Chromatic Level
7. Achromatic Level
8. Encoding Medium
9. Style
10. Information Level
11. Single-Multiple
12. Figure-Ground Relationships
13. Number and Type of Figural Elements
14. Number and Type of Ground Elements
15. Completeness of Figural and Ground Element
16. Fidelity to Referent
17. Normal and Abnormal Environments
18. Figural Placement
19. Viewing Angle
20. Lighting of Subject Matter
21. Shading--Tonality
22. Continuous Tone--High Contrast
23. Line Width
24. Transparent, Opaque, Translucent
25. 2-D and 3-D
26. Perspective Cues
27. Motion Cues
28. Proportion
29. Layout--Treatment, Bleed
30. Content--People, Places, Things, Concepts
31. Ancient, Contemporary, Future
32. Reader to Complete or Manipulate Visuals

The number of points into which the final scales were divided ranged from 4 to 43 (Tables 8 and 9). There were undoubtedly many more points on each scale that could be discriminated. The choice of interval between points was one in which primary consideration was given to the reduction of subjectivity and to the elimination of differences which (though discriminable and of importance to an artist, photographer, or printer) were judged to be relatively inconsequential to learning (except to learning about the media themselves). Neither criterion was completely met.

The relevance of the scales to learning remains to be demonstrated empirically. In fact, it is not so much that the scales are to be verified as criterial to learning, but rather that they constitute a framework within which systematic research about pictorial stimuli can begin. Such research will probably establish the irrelevancy of part or all of some scales. It may also lead to the design of still other scales. The importance of the present effort, then, is largely that it provides a diversity of defined entry points for controlled research of the pictorial domain.

The taxonomy not only has utility for post hoc application to a given sample of illustrations (such as in this study), but perhaps more importantly, it constitutes a rigorous framework for the construction of experimental stimuli with specified characteristics. In controlled research, some of the physical characteristics could be held constant in an informed way while others could be systematically varied.

Because of the above rationale, the attempt was made to choose physical characteristics that were judged to be of decoder significance. While it is probable that the encoders using this taxonomy (designers of instructional materials as well as researchers making experimental stimuli) are more apt to employ encoder terms (photo, drawing, painting), their ultimate concern is the behavior of the decoder (subject, learner). Although one scale deals expressly with encoding media and another with encoder style, the others are intended to avoid encoder categories. Neither of the two encoder-oriented scales will appear adequate to knowledgeable encoders but both may have some significance to decoders.

As noted in Chapter III the delineation of an area that constitutes an illustration from other areas on a page sometimes required judgments of instructional function and unity as opposed to perceptual unity. The result was that occasional illustrations include a diversity of physical types (size, color, framing, information level, encoding medium, etc.). In such cases it was impossible to categorize the illustration univocally with regard to such characteristics. One part of an instructionally unified illustration might include two colors, for example, while another part might include none. Such "mixed" conditions were relegated to a point 9 in most scales for convenience in identification. Consequently, the numbering in some scales is discontinuous. The Chromatic Scale, for example, includes points 1-6 plus point 9.

For a given illustration it is possible to derive an eleven-digit code number that consists of the appropriate scale number from each of the 11 scales. Such a number might appear as (546 ABC 7219832). For further explanation, see Appendix F.

There follows a brief description of each physical type scale, information concerning the rationale for each, and a few possible research questions related to each.

It will be recalled from the Unit of Analysis section of Chapter III that the physical scales deal with the elements (pictorial plus possible verbal and/or design) which comprise pictorial unit (U_p) of the illustration.

Physical Scale 1: Area

This 9-point Scale (Table 5) is based on the number of square inches covered by the pictorial unit, which ranged from 0 to 140 square inches, the 140 square inches approximating the area of a double page spread in the largest history textbook in the sample. The range was not divided into 9 equal parts. At the lower end the intervals are more closely spaced to permit greater differentiation of sizes among the more numerous small sizes.

TABLE 5. SCALE 1: DETERMINING THE AREA OF THE PICTORIAL UNIT

Point	Number of square inches
1	0-4
2	5-8
3	9-12
4	13-17
5	18-25
6	26-40
7	41-80
8	81-110
9	111-140+

This Scale is particularly applicable to textbook illustrations but would be readily adapted to include larger illustrations in Life magazine or even in wall charts or projected slides.

The use of a grid (ruled in inch squares) facilitated measurement, particularly of pictorial units with a non-linear shape. The procedure of counting each square which included any portion of a pictorial unit tended to exaggerate absolute sizes, but provided reasonably reliable estimates of relative sizes.

The complete description of Scale 1 together with examples of its use are given in Appendix F.

Related research questions include the following:

1. Does the relative size of an illustration serve as a cue to the learner as to the importance of the illustration?
2. Is the amount of attention given an illustration (number and duration of eye fixations) a linear function of the size of the illustration?
3. Is the optimum size of an illustration an inverse function of the learner's familiarity with the subject matter of the illustration?
4. Does the optimum size of an illustration depend on the amount of detail (information) to be included? At what information level should one illustration be divided in two?

The above questions are offered in partial fulfillment of one of the objectives for this study as stated in Chapter II, namely to stimulate the generation of research questions regarding the relation between the characteristics of illustrations and the associated learning by students. It must be emphasized that the intent is stimulation not specification, for the above are not considered either to be conceived or stated with adequate rigor. Conspicuously absent is reference to the related literature. While certain research is known by this writer to be related, directly or indirectly, to the above, none is included here lest it be interpreted as the product of a thorough search. In sum, and to re-emphasize, the above questions are intended to suggest possible researchable problems rather than prescribe the design of such research or demonstrate its relationship to other research.

Physical Scale 2: Framing

This 8-point scale is suggested in Table 6. See Appendix F for the pictorial examples without which adequate definition of the framing categories is impossible. Note the categories extend from actual framing to implied framing. Actual framing was defined as having a distinct line or abrupt edge; an implied frame had neither. A pictorial unit with implied framing was framed only in the sense that the objects pictured had edges, and any linear frame was by implication only. In between the actual and implied conditions is that condition called "bleed" in which the edge of the pictorial unit extends either to the edge of the page or to the center fold of the page.

The implied frame condition is perceptually unique. The ground of the pictorial or design elements is perceptually continuous with the ground of the verbal elements, their common ground being the paper of the page itself. No linear frame denotes where the ground of the picture ends and the ground of the text begins. The pictorial ground is indeterminate. This fact may appear to give the pictorial elements a floating or detached or uncertain status that might profitably be the object of empirical investigation.

TABLE 6. SCALE 2: DETERMINING THE FRAMING OF THE PICTORIAL UNIT

Point	Description
1	Actual frame . . . distinct line on four sides
2	Actual frame . . . abrupt edge on four sides
3	Actual frame . . . distinct line or abrupt edge but with bleed on 1-3 sides
4	Bleed on all four sides
5	Combinations of actual and implied frames
6	Implied frame with bleed on 1-3 sides
7	Implied frame on four sides
9	Mixed framing (framing that doesn't fit into any other point on this scale)

Possible research questions or problems might include the following:

1. What is the influence of the implied frame condition on the learner's estimate of realism or authenticity?
2. Does the implied frame condition maximize the learner's attention (fixations) on the figures or does it permit wide and unrestricted (by a frame) excursions over the page?
3. Are eye movements back and forth between picture and text more frequent when unrestricted by an intervening frame?
4. As the reader turns a page, is his entry into a picture area facilitated by an implied frame as compared to an actual frame?

Note that the intent of the above questions is research stimulation rather than rigorous, literature-conscious, research specification. A more adequate statement of this disclaimer is given following the questions for Scale 1.

Physical Scale 3: Configuration

This 8-point Scale covers shapes such as squares, circles and ellipses, and amoeboid and free forms, as indicated in Table 7. It categorizes the basic shape or outline of the pictorial unit, which is related to the actual or implied frame that contains it. If there is an actual frame, its shape becomes the determiner of the configuration; however, if there is an implied frame, the shape of the figure(s) or ground determines the configuration. Adequate definition of the points of the Scale requires careful attention to the pictorial examples in the taxonomy itself, Appendix F.

TABLE 7. SCALE 3: DETERMINING THE CONFIGURATION OF THE PICTORIAL UNIT

Point	Description
1	Square
2	Horizontal rectangle
3	Vertical rectangle
4	Irregular rectangle
5	Circular and ellipsoid
6	Free-form, amoeboid
7	Other shapes
9	Mixed shapes

Related research questions might capitalize on the intuitions of artists regarding the affective characteristics of a rectangular form, for example, as compared to an amoeboid form. Measures might well include the use of semantic differential scales and pupil-dilation responses.

Physical Scale 4: Position

The 43 points on this Scale are arbitrary designations for the position(s) on the page which the illustration can occupy. See Table 8. The page was imagined as being divided into six areas, located and lettered as in Figure 8. A pictorial unit could be located in any one of these positions or in any combination. See Appendix F. The number of possibilities is over 40, and when an adjacent page is added the number easily exceeds what is of probable research significance.

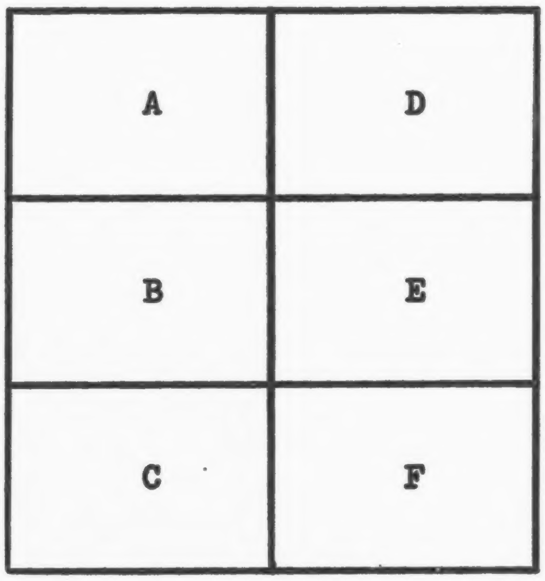


Figure 8. Positions of Illustration on a Textbook Page

Although it would be premature to indulge in extensive combining of categories, a practical delimitation was necessary. Each of the possible combinations of positions for a single page was assigned a scale number with the exception that all combinations including areas associated by corners, in contrast to sides, were combined into one category, point 42. Also all combinations including any part(s) of two adjacent pages were combined, point 43. The scale numbers and associated positions are shown in Table 8.

TABLE 8. SCALE 4: DETERMINING THE POSITION OF THE PICTORIAL UNIT

Point	Position	Point	Position	Point	Position
1	A	16	ABE	31	BCEF
2	B	17	ADE	32	BDEF
3	C	18	BCE	33	CDEF
4	D	19	BCF	34	ABCDE
5	E	20	BDE	35	ABCDF
6	F	21	BEF	36	ABCEF
7	AB	22	CEF	37	ABDEF
8	AD	23	DEF	38	ACDEF
9	BC	24	ABCD	39	BCDEF
10	BE	25	ABCE	40	ABCDEF
11	CF	26	ABCF	41	Z
12	DE	27	ABDE	42	Diagonals
13	EF	28	ABEF	43	Double spread
14	ABC	29	ADEF		
15	ABD	30	BCDE		

For most taxonomic purposes, the placement of a pictorial unit on a page can be adequately denoted by simple notation: A, DEF, BC, etc. It was primarily for the Chi-Square analysis that the Scale shown in Table 8 was constructed.

Related research questions include these:

1. Is an illustration at A or including A (Figure 8) more likely to be "read" than one in any other location?

2. How is the "strength" of the A position affected by verbal reading continuity, for example the case where the F position on the previous page was an illustration? In contrast, how would the "strength" of the A position be affected if the material in F (previous page) ended in a period or a broken sentence with carry over?

3. Given a double column verbal format, which of the following position factors for illustrations draws the most attention (frequency and duration of fixation):

   a. absolute position on the page, i.e., A to F or
   b. relative position on the page, i.e., proximity to associated text?

4. What innovative formats permit more functional patterning and sequencing of verbal (discursive) elements and pictorial (nondiscursive) elements?

5. What order of encounter (verbal followed by pictorial or pictorial followed by verbal) is positively associated with various learner behaviors and objectives?

Note that the intent of the above questions is research stimulation rather than rigorous, literature-based, research specification. A more adequate statement of this disclaimer is given following the questions for Scale 1.

Physical Scale 5: Elements: Pictorial, Verbal, Design

This 4-point Scale is an accounting of the type(s) of elements present in the pictorial unit. As discussed in the Definitions section of Chapter III, one type of element (pictorial) must by definition be present for a configuration to be called a pictorial unit, and one type of element (verbal) or another type (design) or both could also be present. As can be seen in Table 9, the Scale consists of the possible combinations of the three elements in which pictorial elements are present. The other three possible combinations--design, verbal, and combination of verbal and design--were excluded by definition from this taxonomy of illustrations, although any broader study of textbook components might profitably include them. In Chapter VI, Verbal Modifier Taxonomy, further consideration is given to types of verbal configurations that are associated with illustrations.

TABLE 9. SCALE 5: DETERMINING THE PICTORIAL, VERBAL, AND/OR DESIGN ELEMENTS OF THE PICTORIAL UNIT

Point	Description
1	Pictorial elements only
2	Combination of pictorial and verbal elements
3	Combination of pictorial and design elements
4	Combination of pictorial, verbal and design elements

Definitions of the three elements as used in this study were given in the Definition section of Chapter III. Several otherwise indeterminate elements were specified as pictorial in the definition (such elements as the lines and areas in time lines and number lines, graphs, and structural formulae). Perhaps such lines and areas should have been considered design elements, but they do in some respect (quantitative, spatial, or other) resemble objects or events, and thus were considered pictorial. Certain other elements and configurations have been designed to resemble both objects and events and alphabetical and numerical symbols. Examples of such are shown in Figure 9. Although none of these hybrids occurred in the sample, they are not uncommon in advertising and may be of research interest.

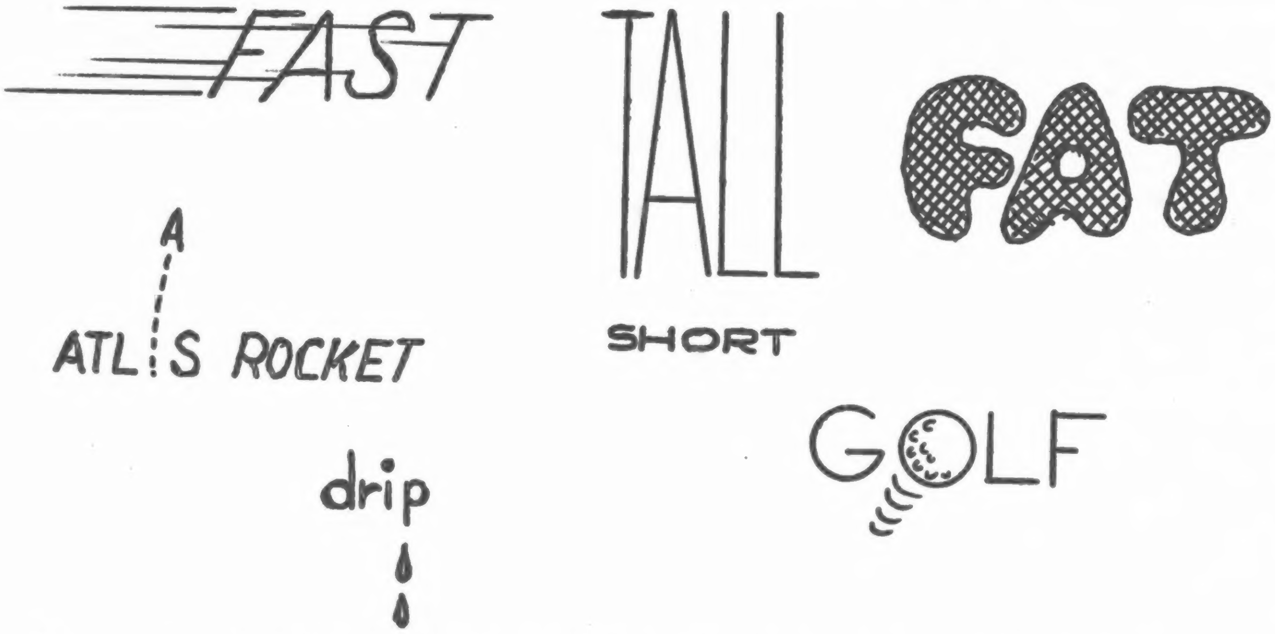


Figure 9. Configurations Having Both Pictorial and Verbal Characteristics

Possible research questions and topics include the following:

1. Can behavioral definitions of the elements (pictorial, verbal, design) be developed? Left to right eye movements might, for example, define verbal elements. Perhaps the simple question, "What does this configuration resemble?" might elicit a defining response.

2. Clearly ambivalent stimuli, such as in Figure 9, might be employed in research aimed at better operational definitions of the elements.

3. The ambivalent stimuli might be used, with systematic changes in relative verbalness and pictorialness, to test the preferences of learners for one or the other. These preferential behaviors might be shown to be associated with other learner factors such as age, sex, I.Q. (verbal or nonverbal), relative ability to grasp concepts in verbal or pictorial mode, etc.

4. What learner behaviors are associated with verbal instruction, what with pictorial, and what with the two combined?

5. The basic area of the presence and role of pictorial and/or verbal elements in thinking, creating, and problem solving could profitably be investigated.

Note that the intent of the above questions is research stimulation rather than rigorous, literature-based, research specification. A more adequate statement of this disclaimer is given following the questions for Scale 1.

Physical Scale 6: Color (Chroma)

This 7-point Scale quantifies the relative number of "colors" observed in the illustration. It includes the range from no-color to full-color as indicated in Table 10.

TABLE 10. SCALE 6: DETERMINING THE CHROMATIC TYPE OF THE PICTORIAL UNIT

Point	Description
1	Non-chromatic (no color)
2	Mono-chromatic (one color)
3	Duo-chromatic (two colors)
4	Tri-chromatic (three colors)
5	Poly-chromatic (more than three colors but not full color)
6	Full-chromatic (appearing like a full color photo or realistic drawing)
9	Mixed-chromatic

This Scale is intended as a gross index in that it considers only major hues (ones having common names). The judgment was that further delineation of hues, tints, and shades, though discriminable and classifiable, probably exceeds instructional relevancy for most purposes. While precise color discriminations are criterial to some concepts in some fields (diagnosis in medicine, chromatography in chemistry), these kinds of concepts were rare in the illustration sample. The 7-point Scale seemed to distinguish adequately among grossly differing illustrations. See examples in Appendix F.

The distinction between gross color differences (which were to be counted) and the not-so-gross color differences (which were not) was occasionally a source of disagreement among judges. However, whether for economic reasons or other, colors (other than full color) in the illustrations were generally found to be either grossly different in hue or minimally different. This circumstance is probably due in part to the fact that color frequently was used to emphasize or distinguish between attributes of an illustration, and, hence, hues were chosen which were readily distinguishable.

Color has been the object of much research in perception and to a lesser degree in learning. Possible further studies could consider the following:

1. Are color factors criterial in their influence on affective behaviors? Measurements might include semantic differential scales and pupil dilation responses.

2. Is such affective behavior, if observed, associated either with more learning or with more effort (frequency and duration of eye fixations) in perception or learning?

3. Do points on the chromatic scale differ in the extent to which they evoke learner judgments of "realism"?

4. Are illustrations judged to differ in realism responded to differentially in terms of credibility, generality, and accuracy?

5. Does color, when not a relevant cue, function as a distractor, i.e., as an irrelevant cue which reduces the efficiency of concept formation? Is there an interaction between cue relevance and cue affectivity factors.

6. Under what conditions does color function as an attention-directing device? Eye movement analysis could be employed.

Note that the intent of the above questions is research stimulation rather than rigorous, literature-based, research specification.

Physical Scale 7: Non-Color (Achroma)

This 7-point Scale quantifies the relative number of shades of grey present. It includes the range from non-achromatic to full-achromatic as indicated in Table 11. See Appendix F for more adequate differentiation of categories by pictorial example.

TABLE 11. SCALE 7: DETERMINING THE ACHROMATIC TYPE OF THE PICTORIAL UNIT

Point	Description
1	Non-achromatic (neither black nor greys present in the picture)
2	Mono-achromatic (either black or one shade of grey)
3	Duo-achromatic (black and one shade of grey or two shades of grey)
4	Tri-achromatic (black and two shades of grey or three shades of grey)
5	Poly-achromatic (more than three achromatic types--but not full achromatic)
6	Full-achromatic (appearing like a full black and white photo or realistic drawing)
9	Mixed-achromatic

Although all achromatic values from black to white belong in this Scale, white (usual color of the page) was omitted because of its pervasiveness. Thus, a black silhouette on a white ground would be classed as Mono-achromatic (Point 2) on the Scale, although a more precise classification might seem to be Duo-achromatic, there being both black and white. However, if both black and white were counted there would be difficulty in conceiving of a Mono-achromatic condition except one that was uniformly white or black or grey, i.e., a condition not likely to be considered a pictorial unit.

All the above ratings are in terms of the appearance, to the unaided eye, of black or grey. Greys achieved by the screen pattern of tiny black dots (normal to printing processes), though technically black, are considered grey when they appear grey at normal viewing distance and with the unaided eye.

Possible related research questions are as follows:

1. Would a subject asked to sort a series of illustrations (same subject matter) on a scale of realism put them in the same order as their achromatic scaling?

2. What other differences in learner responses are associated with differences in achromatic rating? One might consider eye-movement patterns and pupil-dilation responses.

3. Does a learner exhibit different affective responses to the Full-achromatic condition than to the Mono-achromatic? A possible task could be sorting illustrations in order of preference.

4. How are the above responses to illustrations affected by systematic changes in the subject matter of the illustration--subjects that are more or less familiar, more or less intricate in detail, more or less emotion inducing?

5. Are Duo-achromatic illustrations as attention getting and sustaining (eye-fixations) as Duo-chromatic? Which is associated with the greater affective response (pupil-dilation)?

Note that the intent of the above questions is research stimulation rather than rigorous, literature-based, research specification.

Physical Scale 8: Encoding Medium

This 4-point Scale includes only the most basic and apparent differences between encoding media. It includes drawings, photos, etc. as indicated in Table 12. For a more precise definition by example, see Appendix F.

TABLE 12. SCALE 8: DETERMINING THE ENCODING MEDIUM FOR CREATING THE PICTORIAL UNIT

Point	Description
1	Photographic encoding medium
2	Artistic two-dimensional encoding medium
3	Mechanical encoding medium
9	Mixed encoding medium

Other scales such as Chromatic, Achromatic, Style, and Information Level, when taken together, can essentially define the medium. For example, a black and white photograph will in most cases be an Achromatic Point 6, a Style Point 1, and an Information Level Point 1. Nevertheless, it was felt that for encoders, and even for decoders, illustrations are commonly referred to by medium. It follows that learners may have additional associations for "photo" or "drawing" that could affect their responses to such media used as teaching materials.

Actually, the number of media discernible to an artist is large and growing, but it was judged that most of these are not recognizable by the non-artist and many would not be criterial for learning (except about the media themselves). Further, the sample of illustrations did not include a representative or adequately diverse assortment of such media to provide a basis for further subdividing the Scale. It was judged that the other 10 Scales would serve to differentiate some of the media not included in this Scale and would perhaps do so with reference to more basic perceptual differences. The issue remains wide open, however, as the extent to which media differences of whatever type or degree are determinative of instructional outcomes.

Points of difficulty in devising this Scale were more extensive than the obvious, "Which media should be included?" It was apparent, for example, that essentially all illustrations in a textbook went through some photographic process in order to prepare them for printing. Consequently, the taxonomy emphasizes that the original medium is the one to be classified.

A separate category was considered for three-dimensional artistic media such as statuary and models. Because such three-dimensional artistic media appeared in the sample as photographs and because they were so few in number, they were included in Point 1, Photographic. Three-dimensional artistic media become potential additions to the Scale, along with many others, when and if research evidence justifies it.

Possible research questions include the following:

1. What attributes are criterial in a learner's discrimination between photo and drawing? (Use stimuli difficult to class as one or the other.)

2. What learner behaviors, cognitive and affective, are associated with illustrations known by the learner to be photographs, paintings, drawings?

3. What kinds of statements by learners are made about photos, drawings? Do they differ in number, specificity, noun-verb-adjective content, confidence or certainty?

Note that the intent of the above questions is research stimulation rather than rigorous, literature-based, research specification.

Physical Scale 9: Encoding Style

This 6-point Scale includes a range of styles from Realistic to Impressionistic, as shown in Table 13. Art styles are associated with certain periods of history and certain artists, and new styles have been appearing with increasing frequency in recent years. The attempt in this Scale was to be eclectic and to be cognizant of but independent of categories useful in the Fine Arts. The choice of categories was influenced primarily by the sample of illustrations, though Point 5, Impressionistic, for example, is rare in the sample. The Points are more adequately defined by example in the Taxonomy, Appendix F.

TABLE 13. SCALE 9: DETERMINING THE ENCODING STYLE OF THE PICTORIAL UNIT

Point	Description
1	Realistic style
2	Cartoon style
3	Diagrammatic style
4	Design style
5	Impressionistic style
9	Mixed styles

The most apparent stylistic differences in the sample were closely associated with individual books. The intent of publishers may be to maintain a certain stylistic integrity throughout a book. The effect in some cases is monotony, although many art editors managed to include a pleasing degree of variety while maintaining a certain stylistic unity. One could construe stylistic unity or integrity to mean stereotypy, but, regardless, the relevance of the phenomenon to learning remains to be adequately investigated.

This Scale was made with primary reference to Artistic two-dimensional media (Scale 8, Point 2), for these evidenced the most apparent and diverse stylistic attributes. The range of styles discernible in this sample was relatively restricted for the photographic medium and more severely restricted for the mechanical medium.

Possible related research questions are as follows:

1. Can relationships be demonstrated between learner behavior (except in the Fine Arts) and stylistic variables?

2. Does the learner who is naive about style evidence awareness of stylistic variables in discrimination tasks?

3. In a matching task would the learner associate certain styles with certain subject matters?

4. Do certain styles receive greater attention (frequency and duration of eye-fixations) than other styles?

Note that the intent of the above questions is research stimulation rather than rigorous, literature-based, research specification.

Physical Scale 10: Information Level

This 6-point Scale is based on the amount of pictorial information of several types that the illustration contains. As is evident in Table 14, the Scale deals with the degree of presence or absence of four types of information: background, shading of figure, other depth dues (dimensionality), and interior detail in figure. The points on the Scale are much more adequately defined by example in the taxonomy, Appendix F. In general, they range from the appearance of a detailed black and white photograph to that of a black silhouette or outline drawing on a uniform white field.

TABLE 14. SCALE 10: DETERMINING THE LEVEL OF INFORMATION OF THE PICTORIAL UNIT

Point	Description
1	Natural environment, full shading, full dimensionality, full interior detail
2	In limbo, full shading, full dimensionality, full interior detail
3	In limbo, limited shading, limited dimensionality, full interior detail
4	In limbo, no shading, limited dimensionality, limited interior detail
5	In limbo, no shading, no dimensionality, no interior detail
9	Mixed levels of information

It is possible for each of the four types of information to occur independently, i.e., in any amount and in any combination. For example, a silhouette figure (Point 5) could be placed on a natural environment ground (Point 1). However, the tendency in this sample is for illustrations to evidence a limited range of combinations which the Scale is intended to represent. Occasional marked deviations from this, such as the example above, were classed as Point 9, Mixed. Minor deviations, involving for example a combination of attributes from Points 4 and 5, were resolved by judges with reference to the over-all criterion of relative pictorial information level.

There is evidence from perception research that ground is least attended to and that figural form is most attended to. This perceptual principle is reflected in the construction of the Level of Information Scale (at least the Point 1 and Point 5 ends of the Scale) in that ground is the first type of information to be dropped and figural form is retained throughout. The rank order of attention to other factors, such as shading, depth cues, and interior detail, seems to be less well-established.

It may be of interest to note that research involving pictorial stimuli (as represented in psychological journals) typically employs Point 5 materials, usually outline drawings. This practice may be justified in many applications because it retains the basic attribute of figural form. However, in studies purportedly investigating the domain of pictures *per se*, Point 5 stimuli cannot be defended as representative of the population.

Possible related research questions and problems are as follows:

1. Can evidence be obtained to assess the affective and cognitive correlates of atypical combinations of the four types of information (environment, shading of figure, dimensionality, interior detail of figure)?

2. Are response tendencies established with reference to Point 5 stimuli also characteristic of Points 3 and 1?

3. Is the disproportional occurrence of pictorial information types across subject matters defensible in terms of either learner behavior characteristics or subject-matter characteristics?

4. In what ways might research challenge the common sense assertion that an illustration must include those types of pictorial information (ground, figure, detail, etc.) which are judged to be criterial to learning and must exclude or reduce those judged to be non-criterial? Recent research related to this problem has typically employed what might be called nonsense figures with which criteriality

is arbitrary. If criteriality in certain mathematics or science illustrations were more logical than arbitrary, would the negative effect of non-criterial information be less detrimental to learning?

Note that the intent of the above questions is research stimulation rather than rigorous, literature-based, research specification.

Physical Scale 11: Unification/Separation

This 5-point Scale is based on the fact that the discriminable components of pictorial units vary in their apparent unity. The Scale is verbally represented in Table 15, but a much more adequate definition of each point is provided by the examples in the taxonomy, Appendix F.

TABLE 15. SCALE 11: DETERMINING THE DEGREE OF UNIFICATION/SEPARATION OF THE ELEMENTS WITHIN THE PICTORIAL UNIT

Point	Description
1	Fully unified
2	Mostly unified
3	About as unified as it is separated
4	Mostly separated
5	Fully separated

If only perceptually unified areas had been defined as illustrations, there would be less need for this Scale. However, as discussed in the Definition section of Chapter III, there were instances where several perceptually separate pictures were together considered as one illustration because of their instructional unity.

Initially the Scale consisted of but two points: single picture and multiple picture. Subsequently, it became apparent that the multiple-picture pictorial units varied widely, some appearing almost as unified as a single picture and others appearing more separated. The above Scale is intended to delineate these perceptual differences.

This Scale is admittedly highly subjective. Although the directions for using the Scale (Appendix F) describe and give examples of the several perceptual factors (similarity, proximity) that presumably are associated with judgments of unification/separation, there is no explicit quantification of these. The implication is that if a picture appears consistent with several unifying factors, it should be judged more unified than if it exemplifies only one factor. Although this implication fosters a higher reliability among judges, it may not always yield judgments that are consistent with an over-all, non-analytical estimate of unity.

Possible related research problems and questions are as follows:

1. The essentially unanswerable problem is that of the proper balance between unification and separation. Elements in learning which are to be associated or considered exemplars of a set or concept should presumably be taught so as to emphasize their commonness (unity) and de-emphasize their differences (separation). But, the factors separating one set from another cannot be overemphasized because several divergent sets may subsequently need to be combined into a superordinate category by means of common attributes.

2. In the broader sense the factor of unification/separation is implicit in the design of the entire visual unit (textbook page) as well as chapters, etc., and thus involves the unresolved problem of the relationships between pictorial and verbal elements. In some ways the two are incompatible (discursive vs. nondiscursive structure) and must presumably be "read" separately if not presented separately. On the other hand they are apparently instructionally interdependent (frequently if not irrevocably) as employed in textbooks. In what ways can pictorial and verbal elements be combined without violating the unique attributes of either?

3. What do readers (different age levels, aptitudes, subject matters) reveal about the "way" they "read" words and pictures of various types in various combinations and configurations? Case studies involving eye-movement data could penetrate this inadequately explored question.

4. What combination of what perceptual factors (objectively defined or at least defined by example) elicit encompassing, combining, superordinate responses and which elicit delineating, separating, subordinate responses?

Note that the intent of the above questions is research stimulation rather than rigorous, literature-based, research specification.

Possible Other Scales

Figure-Ground. Prominent in the early thinking of the research team were figure-ground scales. The figure-ground concept was known to be based on perception research, and it seemed to be highly relevant to learning variables. However, it proved to be too subjective, in the opinion of the staff, for inclusion in this taxonomy. A basic difficulty was that perceptual and instructional criteria were difficult to isolate. The perceptual "figure" might be a research scientist, while the instructional "figure," according to the caption or context, might be the research apparatus beside the scientist. Judgments limited to perceptual factors were found to be equivocal as well, because many illustrations appeared multi-figured and/or multi-grounded. They were not the simple two-plane pictures on which figure-ground research was based. Instead they exhibited multiple planes: a tree in foreground, a person farther back, a building behind him, and sky behind that. Also, the perceptual criterion employed proved to be two factored: first, the "spatial distance" between near objects (presumably figure) and more distant phenomena (presumably ground), and second, the "dominance distance" between attention dominating objects (presumably figure) and the more subordinate phenomena (presumably ground).

For staff judges the spatial distance factor proved to be more reliable, i.e., discriminable aspects of an illustration could be ordered from nearest to farthest. Uncertain, however, was the choice of the one or more nearer aspects that should be called figure and the one or more distant aspects that should be called ground. The most unequivocal strategy seemed to be to call the most distant specifiable aspect "ground" and call all others "figure."

The failure to include a figure-ground scale does not obviate the consideration of such factors. Experimental stimuli of instructional significance can be designed with two planes that can operationally be defined as figure and ground. It is probable, too, that learner behaviors could be employed to categorize operationally what aspects in a particular illustration function as figure and as ground. For example, the objects or relations named first by a subject can be considered figure and the others as ground. Or eye movement analysis can be employed with the areas receiving the larger number or duration of fixations classed as figure and the others as ground.

The Scale in the taxonomy that includes some part of the figure-ground relationship is Scale 10: Level of Information. Point 1, the highest point on this Scale, includes figure and ground, while the next Point includes only figure which is in limbo, i.e., devoid of its natural background.

Concrete-Abstract. A frequent consideration in making, using, or testing audio-visual instructional materials is the concrete to abstract continuum. Pictorial elements are plotted toward the concrete end and verbal toward the abstract end of the continuum, or verbal and pictorial elements may not be conceived as one continuum but comprising two separate concrete to abstract continua.

The concrete-abstract dimension is indirectly a part of several physical-type scales: Chromatic, Achromatic, Style, and Level of Information. However, difficulty was encountered by the staff in coping directly with the concrete-abstract dimension. The most appropriate criterion for this dimension was judged to be "fidelity to referent," i.e., to what degree does the illustration resemble the referent, the phenomenon represented. Difficulties in applying this criterion were of two types.

One difficulty was the variability of the judge's knowledge of the referent. For example, a microscopic photo of an organism might be identified by a scientist as Penicillium chrysogenum (very limited or concrete class), but by a lay person as a greenish thing or strange small plant (relatively inclusive or abstract class). Similarly a stylized or cartoon treatment (relatively abstract) of a well-known American public figure might readily be identified as Senator Jones (identity class, most concrete) by most Americans, while a very detailed full-color photo (concrete) of a less-known European might be called a "good-looking young man" (large, abstract class). Then, too, who is to judge the comparative fidelity of several drawings of George Washington? These examples suggest the overriding influence of prior knowledge on a judge's estimate of the fidelity of an illustration to its referent.

Another difficulty was that the referent intended by the textbook author or editor was frequently unknown and could in itself be variably concrete or abstract. For example, an aerial photo of Chicago could be intended to represent the concrete concept "Chicago" or the more abstract concept "midwestern city." The fidelity of the photo is greater for one referent than for the other. Thus, there appeared to be no objective basis for judging concrete to abstract on the basis of fidelity to referent except in the context of a prescribed referent and a particular judge.

Somewhat analogous scales are, however, included in the taxonomy. It seems likely, for example, that the greater the number of shades of grey discerned in an illustration the greater its probable fidelity to referent, i.e., the greater the concreteness. The same would hold for numbers of colors, although in both cases the addition of certain values (colors or greys) could conceivably lower fidelity. The Level of Information Scale also is related to the concrete-abstract dimension. An illustration void of background, shading, depth cues, and interior details (essentially a silhouette or outline drawing) is apt to be lower in fidelity (i.e., more abstract) than one which includes all such attributes.

Judging Procedures

Judging procedures evolved concurrently with the development of the taxonomy. Each revision of a scale was tested informally on other staff members. At two later stages of refinement, the scales and procedures were tested by three non-staff people, specifically graduate assistants in the Audio-Visual Center. These naive judges (naive before testing with regard to the particular scales) classified a small sample (10-20 pictorial units) on all 11 scales. Deviations from staff judgments were noted, discussed with the naive judges, and adjustments made in procedures and scales.

Judging for purposes of the reliability estimate for each scale was done by another set of comparable naive judges using only the instructions accompanying the present taxonomy (Appendix F). This procedure was to approximate the conditions of use by non-staff persons. The pictorial units judged were a stratified random sample of 40 illustrations (from the sample of 787) in which strata were the four subject-matter areas.

Ten illustrations were chosen per subject area (stratum). There follows the interjudge agreement for each nominal scale given by percentage, i.e., percentage of total agreement (3 of 3 judges) and of partial agreement (2 of 3 judges). There follows additionally, for the 5 scales that were ordinal, Kendall's Coefficient of Concordance (W) as a reliability estimate and a Chi-Square test of the probability that the W value obtained could have occurred by chance.

Scale 1: Area--$W = 0.998$, $p < .001$
Scale 2: Framing--32.5% total agreement, 47.5% partial agreement
Scale 3: Configuration--12.5% total agreement, 75.0% partial agreement
Scale 4: Position--62.5% total agreement, 32.5% partial agreement
Scale 5: Elements--40.0% total agreement, 47.5% partial agreement
Scale 6: Chroma--$W = 0.845$, $p < .001$
Scale 7: Achroma--$W = 0.841$, $p < .001$
Scale 8: Medium--50% total agreement, 50% partial agreement
Scale 9: Style--57.5% total agreement, 42.5% partial agreement
Scale 10: Information--$W = 0.648$, $p < .001$
Scale 11: Unification--$W = 0.552$, $p < .01$

In addition to the above judging by naive judges for reliability estimation purposes, the entire sample of 787 illustrations was categorized on all 11 scales for the eventual Chi-Square tests of independence. These judgments were by the research staff, those with art or graphic communication experience who had chosen and refined the 11 scales. It was felt that the final physical-type judging of the sample should be as accurate as possible with reference to the rationale of the taxonomy and the definitions of each category. Consequently, staff judgments were the data used in the Chi-Square analyses. The two staff authorities judged the sample independently and then discussed their occasional differences until a consensus was achieved.

See Chapter VII, Results, for the frequency distributions of the illustration sample across each physical type scale and for Chi-Square tests of the relationships between physical types and the other types--subject matter and objective.

CHAPTER V

OBJECTIVE TYPE TAXONOMY

Introduction

It was not so much the intent of this study to design a taxonomy of educational objectives as to have teachers apply an existing one to a sample of instructional illustrations. However, after careful consideration, acceptance *in toto* of any existing taxonomy seemed to be unwise. As is apparent in a recent summary (3) of studies employing a well-known taxonomy, users have frequently decided to modify the taxonomy to their own needs. For example, Milholland (14) reports an adaptation for use in a first course in Psychology; Ayers (1) reports an adaptation for 10th grade science; McGuire (12) reports an adaptation for use in Medicine; and Sanders (16) reports an adaptation for in-service teacher education. The above were with reference to the taxonomy of the cognitive domain by Bloom (2), henceforth referred to as Bloom's taxonomy. The present study considered in addition the taxonomic efforts of Krathwohl, Bloom and Masia (8), Lindvall (10), and Gagné (4).

Analysis of the above reports of users of Bloom's taxonomy revealed several sources of difficulty encountered in its application. There was some doubt that the taxonomy was uniformly useful across divergent subject matters. There was doubt that the six categories are intrinsically hierarchical. There was observed a lack of adequate behavioral specification and delineation of the six categories. There was reported some lack of adequate reliability among judges applying the taxonomy to test items unless the judges had had a considerable amount of training in its use.

In spite of such evaluations, the Bloom taxonomy was selected as the basis for the present study because an examination of other taxonomies, such as Lindvall (10) and Gagné (4), did not reveal any certainty of improvement. The very circumstance of extensive use and modification of Bloom's taxonomy became an advantage over the other less widely tested approaches. The Gagné taxonomy appeared to be conceived in psychological terms and hence of greater potential utility for behavioral description. The behavioral description, however, was not adequate in the judgment of the research staff, particularly for a scale to be used by teacher judges who would be given minimum instruction.

In addition to Bloom and his several revisionists, the work of Mager (11) was particularly relevant. Mager's insistence on behavioral terms for stating objectives served as an antidote for one of Bloom's principal weaknesses.

In sum, the taxonomy for classifying objectives was based on Bloom and Mager although it took on a character of its own that reflects a consensus of the thinking of the staff who designed it. In general, the final objective taxonomy included only part of Bloom's categories and defined these rather differently. It employed only part of Mager's rationale for writing behavioral objectives.

Pretest of Objective Taxonomy

The intent of the pretest was to test a preliminary objective taxonomy both as to its conceptual adequacy and as to its suitability for teachers to apply to textbook illustrations.

A basic problem to be explored in the pretest was that of eliciting student behavioral objectives from teachers without lowering the validity of the teachers' judgments concerning illustrations. Two of the staff had had experience endeavoring to teach graduate students to write behavioral objectives for instructional materials and, thus, were aware of the difficulties. Teachers long accustomed to stating objectives, such as "to demonstrate," "to show," and "to present" (behaviors they as teachers must perform) needed help in orienting their thinking to stating objectives in terms of the behaviors they expect students to perform, such as "to recall," "to synthesize," and "to apply." Such thinking requires a 180 degree switch, a new set of terms, and a judgmental process that involves both imagination and rigor.

The objective taxonomy developed for the pretest employed all six of Bloom's categories but defined them in Mager-like terms. Although Mager's model objective included three parts (kind of performance, conditions imposed, criteria of success), the part ~~that~~ distinguished it from a non-behavioral (or teacher behavioral) objective was the kind of performance, which was revealed primarily in the choice of verb: what was the learner expected to do? An early staff insight was that not only was the verb (actually the infinitive form) the key to the behavioral conception of the objective, but also the verb suggested the type of behavior involved and could thus be the basis for a taxonomy. The potential beauty of the idea was that once a teacher chose a verb for his objective he had done two other things--he had conceived of the objective in behavioral terms and had placed the objective in one of Bloom's categories of objectives. Therefore, his objective was precategorized. As was to be expected, the idea in practice lacked some of its beauty in theory, for although some verbs were quite specific to particular Bloom categories, others were not.

For the objective taxonomy used in the pretest, verbs were chosen to match categories by means of dictionary definitions and staff interpretations. Other verbs were added after study of those used in exercises or questions in the textbooks. Such verbs as "to compute" or "to hypothesize" were found to be quite specific to subject matter in math and science and, hence, were thought to be essential in a taxonomy to be used by teachers in these areas.

The six categories shown in Table 16 correspond in general to Bloom's major categories (Knowledge, Comprehension, Application, Analysis, Synthesis, and Evaluation) although these category headings were not used. Rather, each category was defined by a brief sentence and by 8 to 10 appropriate infinitives.

TABLE 16. PRELIMINARY OBJECTIVE TAXONOMY USED IN PRETEST

Category 1	2	3	4	5	6
Merely to be aware of information and be able to recall it	To understand what knowledge is aiming at (leading to)	To do something with existing knowledge (comprehension)	To take something apart and/or use its relationships	To put something together in a different way	To decide how good something is
To Define Describe Identify List Name Note Recall Recite Recognize Review	To Clarify Discuss Explain Extrapolate Generalize Illustrate (Give example of) Interpret Interpolate Summarize	To Apply Classify Compute Determine Find Perform Predict Solve Write	To Analyze Breakdown Compare Diagram Dissect Distinguish Relate Separate	To Combine Create Design Formulate Invent Organize Plan Prepare Synthesize	To Appraise Approve Assess Choose Criticize Evidence interest in Judge Rate Value

Fifteen teachers of junior high students participated in the pilot study. All were from a local school and neither the school nor these teachers took part in the final study. These teachers were instructed to write two objectives for each of 20 illustrations. The illustrations were part of the final sample of 787 illustrations but were carefully selected from several books to represent something of the breadth of types common to each subject-matter area.

Three teachers from each of four subject areas (mathematics, science, American history, and English) used the preliminary taxonomy to write objectives, while a fourth teacher in three of the four subject areas studied Mager (11) Chapters 1-4 and wrote objectives without reference to the preliminary objective taxonomy (Table 16). This strategy yielded both a comparison between two procedures for instructing the teachers and a comparison within one procedure of the amount of agreement among three teachers writing objectives for the same illustrations.

Instructions for the preliminary taxonomy included a definition of student behavioral objectives and a number of sample illustrations with possible objectives from each subject area. Teachers were to preface their objectives with one of the infinitives listed, Table 16, and were to use the infinitive in a way consistent with the associated meaning of the category. They were to write two objectives (in different categories) for each illustration and indicate their first choice between the two.

The amount of agreement among the first choices of teachers using the preliminary taxonomy is given in Table 17. The number of illustrations out of the 20 for which there was total agreement (three out of three judges), partial agreement (two out of three), and no agreement is shown for each of the four subject areas. Agreement here refers to the choice of category within which the objective was written.

TABLE 17. AGREEMENT AMONG THREE TEACHERS' FIRST CHOICES OF OBJECTIVES FOR 20 ILLUSTRATIONS IN PRETEST

	English	History	Mathematics	Science	Total	Per cent
Total agreement	1	3	1	1	6	7.5
Partial agreement	10	7	13	10	40	50.0
No agreement	9	10	6	9	34	42.5
Total illustrations	20	20	20	20	80	100.0

The unexpected amount of disagreement shown in Table 17 led to some intensive assessments of its possible sources, viz., in the taxonomy, in the procedure, and/or in teacher understanding of the task. Although this assessment led to better control of such sources of disagreement, none of the factors seemed of sufficient magnitude to account for the discrepancies. Attention turned to the illustrations themselves. There emerged the possible explanation that some illustrations in certain contexts could serve a very limited range of objectives, while other illustrations in other contexts could serve a diversity of objectives. It would follow that discrepancies among objectives selected by judges might in large part be attributable to the equivocal character of the illustrations themselves. This possibility will be discussed further with regard to the final taxonomy and the analysis of the ratings of teachers who used it.

Assessment of teacher differences in the pretest revealed a pronounced tendency toward patterning, i.e., no teacher wrote objectives that were equally distributed across types. The most consistent patterns seemed to be characteristic of the subject matter, although within subject areas certain teachers evidenced marked individual preferences (greater frequencies of choices) for certain objectives as compared to their peers. The patterning was thus held to be largely attributable to legitimate differences in subject matter and to the equivocal character of some illustrations. The latter had the effect of permitting each teacher's style (philosophy, methodology) to be partially determinative of the objective type chosen.

None of the above, however, were interpreted as relieving the staff of the obligation to refine further the procedure and the taxonomy. Both were taken to be too ambiguous.

Refined Objective Taxonomy

Choice of categories. The most apparent changes made in the taxonomy were in the choice of categories and the specificity with which they were defined. Many alternative categories and combinations of categories were considered, some from the existing taxonomies and modifications mentioned in the Introduction to this chapter and others from taxonomies devised by each staff member.

The possibility of a three-part taxonomy (Cognitive, Affective, Psychomotor) was rejected as insufficiently definitive, while the combination of the six cognitive categories of Bloom (2) and five affective categories of Krathwohl, Bloom and Masia (8) was considered too complex. Finally decided upon was a combination of parts of both as suggested in Table 18.

TABLE 18. CATEGORIES IN REFINED OBJECTIVE TAXONOMY

Knowledge (Type A)--To recall, recognize, reproduce (subsequently and essentially as learned) the information obtainable from the illustration.

Analysis (Type B)--To separate, identify, compare the components of the illustration (physical components or ideational components).

Synthesis (Type C)--To combine, formulate new relationships, generalize from information obtained in the illustration.

Application (Type D)--To use information (known or given) that involves the illustration (but not for the purposes of analysis and synthesis).

Appreciation (Type E)--To show desirable interest, attitude, attention toward the illustration or its subject matter.

The choice of the particular categories requires some justification, although these categories would not be defended by the staff as having necessary relevance beyond the requirements of this study. The first four categories are identical in label to the first, third, fourth and fifth categories of Bloom's taxonomy; however, they are defined somewhat differently. Excluded were the Comprehension and Evaluation categories of Bloom. The concept of comprehension proved in use to be difficult to delineate behaviorally, i.e., comprehension could be observed in application behavior or analytical behavior but not so obviously as comprehension per se. Hence, this concept was, in effect, distributed across the others. Evaluation behavior was seen to occur as application when it consisted of following a prescribed evaluation scale or system, as analysis when it involved critical examination of separate components, or as synthesis when it consisted of the independent formulation of value or quality statements about something. Consequently, evaluation behaviors were distributed across the Analysis, Synthesis, and Application categories. The decision to eliminate comprehension and evaluation as separate categories was influenced additionally by the necessity of simplification for use by judges with limited familiarity with the taxonomy.

The fifth category, Appreciation, was primarily intended to acknowledge that many illustrations evidence no apparent pedagogical purpose other than an affective one. One teacher in the pretest suggested the addition of such a category. Several interviews with eighth-grade students revealed an awareness of a "decorative" function for some illustrations rather than a direct instructional function. The implicit evaluation in the above comments seemed to be negative, i.e., an illustration lacking apparent substantive relevance must have no other purpose than to make the book look pretty. In contrast, interviews with book designers revealed a high positive value ascribed to the affective character of illustrations. They were thought to add importantly to the acceptability and appeal of the book for both teacher and learner. This seeming conflict could be clarified by empirical investigation.

At least two aspects of the appreciation category were suspect. First, the category was quite probably employed by teachers as a last resort, when they found no other viable alternative. Thus, the category may have functioned as a miscellaneous one. Second, the behavioral characteristics of the category were not adequately specified. The verbs (to show, to evidence, to exhibit) imply observable behavior, but the object of the verb is non-observable (to show interest, to evidence appreciation). This compromise was chosen to maintain some consistency with the behavioral framework of the taxonomy but, at the same time, to avoid being unnecessarily complicated. The observable aspects of appreciation are quite diverse: responses to attitude scales, amount of time spent viewing the illustration, response of a smile or frown, length or frequency of verbal response to the illustration, pupil dilation, GSR, or other physiological responses. Though specifiable, such behavioral aspects are scarcely within the scope of the teachers' task for this study. It was decided that further insistence on behavioral specificity would have the effect of reducing the frequency with which the teacher would choose the category and thus bias his response.

The term "appreciation" was used because it probably had more relevant meaning to teachers than the term affective. The appreciation category is intended to include all of the affective domain (8) that is likely to be relevant to a particular illustration, namely the Receiving (attending), Responding, and Valuing categories.

Revision based on pretest. A detailed questionnaire completed by the fifteen teachers participating in the pretest provided guidelines for revision. For example, the three factors that teachers rated as most difficult were the following:

1. thinking of what the student should do (student behavioral objective)
2. writing two objectives for each illustration
3. writing the two objectives in different categories.

Consequently, in the revised task requirements, items 2 and 3 above were dropped and instructions for 1 were augmented.

Teacher assessment, by questionnaire, was either favorable or neutral to the prescription of verbs and to the effect of such prescription on the appropriateness, specificity, consistency, and difficulty of the judgmental task.

Teachers were asked to add to the list verbs that were more appropriate, delete verbs found least useful, and shift verbs to more appropriate categories, all with reference to their own subject matter. Very few verbs were added or shifted, but a number were deleted. In consequence, the revised taxonomy reflected these changes except that verbs which had relevance to one subject area but none to another were retained. Verbs, such as "to discover" or "to inquire," which were too readily associated with discovery and inquiry methods (and teachers' attitudes toward them) were eliminated. A frequency count of the verbs actually used by pretest teachers also aided in judgments as to which verbs to retain.

The optimum matching of verbs and categories was given additional attention. The pretest teachers raised questions regarding the categorization of only five verbs. However, an informal test among staff not working on the objective taxonomy provided additional information. They were asked to associate each of the pool of verbs with one or more of the six words (knowledge, comprehension, etc.) which label the categories in Bloom's taxonomy. There was unanimous agreement on some verbs and partial or no agreement on others. With reference to this information, the verbs that were more ambiguous as to category membership were deleted from the list or given specificity by means of an added phrase.

Two verbs, "to state" and "to write," were found to be both essential to the behavioral assessment of learning and universal as to objective category. Consequently, they were included in the prescribed list of verbs for each category but with the proviso that they be used consistently with the meaning associated with a particular category. This procedure had the effect of providing an acceptable alternative when none of the given verbs in a category was suitable.

It should be acknowledged that the verbs chosen are not as uniformly behavioral as desired. However, they are a distinct step in the behavioral direction from the verbs which Mager (11) decries, such as to learn, to know, to understand.

Table 19 gives the final objective taxonomy which includes both extensive behavioral definitions of the five categories and the associated verbs to be used in writing objectives.

TABLE 19. GUIDE TO OBJECTIVE TYPES

	APPROPRIATE VERBS
KNOWLEDGE (as a product) Type A. To recall, recognize, reproduce, (subsequently and essentially as learned) the information obtainable from the illustration, that is: to state, write, list information in caption, titles, labels, legends (essentially as given) to recall, reproduce, recognize (subsequently) information found in picture, map, graph, drawing to recall, (subsequently) any of the products of the following behaviors: analysis, synthesis, application, appreciation.	Learner should: state list reproduce write repeat name recall label recognize
ANALYSIS (as a process) Type B. To separate, identify, compare the components of the illustration (the physical components or the ideational components) so as: to distinguish, delineate, dissect into parts to compare, contrast, find similarities and differences to find existing relationships among components (not form new ones, i.e., synthesis) to describe, categorize, identify, explain by its components (based on student's analysis)* to assess, criticize any components (based on student's analysis)*	Learner should: differentiate delineate categorize analyze distinguish criticize find compare assess identify contrast judge select explain (by analysis) write describe separate state locate estimate
SYNTHESIS (as a process) Type C. To combine components, formulate new relationships, generalize from information obtained in the illustration, so as: to summarize, interpret information (not recall of same) to restate in a way or translate into a form new to student to explain (overall), give example of to associate, relate, organize information in illustration in a different way from that given to create, design, formulate, plan new products, principles, concepts, procedures, conclusions to hypothesize, predict, generalize regarding illustration to evaluate whole illustration (based on student's synthesis)*	Learner should: restate explain conclude generalize create hypothesize summarize associate design translate organize predict combine formulate evaluate relate plan write interpret (by synthesis) prepare state
APPLICATION Type D. To use information (known or given) that involves the illustration (not for the purpose of analysis or synthesis) as follows: to apply rules, principles, procedures from the illustration to apply rules, principles, procedures to the illustration to compute, perform, classify, rate, construct or do some other operation to the illustration or with information from the illustration -- all by application of a known or prescribed method to solve problems relative to the illustration	Learner should: apply perform construct use classify do solve categorize state compute rate write
APPRECIATION Type E. To show desirable interest, attitude, attention toward the illustration or its subject matter, as follows: to show interest in any of a variety of observable ways to notice, be attentive to, concentrate on the illustration to evidence interest in the illustration itself, in the information obtained from it, in the related unit or chapter to exhibit preference for, approval of, values about	Learner should: show interest, attention exhibit appreciation, preference evidence attitude, approval notice write be attentive to state concentrate on

*not by application of given rules, procedures, principles, etc.

__Resolution of other questions.__ Several issues unresolved by the pretest were:

1. What were the characteristics of the learner for whom the objectives were to be written?

2. Was the illustration to be considered in isolation or with reference to its context?

3. How could the taxonomy delineate both the basic types of learner behavior and the basic difficulty level of these behaviors?

With reference to the first question, the characteristics of the learner, it was decided to capitalize on the generalized conception of an eighth-grade student that a teacher employs in working with classes or groups of such students. It was assumed that while a teacher might not be able to describe definitively this generalized student, nonetheless in his day-to-day work with such students, he consciously or unconsciously adjusts his assignments, his level and rate of speech, etc., to fit his estimate of their capabilities and his anticipation of their behavior. The instruction to teachers on this matter (General Considerations in Table 20) indicated the teacher should assume the student was "average," and "average" was explained to the teachers as the generalized student described above.

With reference to the second question, inclusion or exclusion of the context of the illustration, it was decided that the context should be considered by the teacher as he conceived of an objective, although the objective must be with particular reference to the information obtainable from the illustration. As indicated in Table 20, item b, the teacher was to assume the student had studied the book

TABLE 20. RATIONALE FOR THE TEACHER'S CHOICE OF OBJECTIVE

General considerations

a. Consider the context, i.e., the topic of the subject matter under consideration and the goals you would have for your students when teaching this topic.

b. Assume that an eighth-grade student has studied the book through the page containing the illustration.

c. Assume he is an "average" eighth-grade student in ability and experience.

Specific rationale

In relation to the above, but with particular reference to the information obtainable from the illustration, which of the following is the most appropriate type of behavior to expect from the student?

To Know--to recall, reproduce, recognize
To Analyze--to separate, identify, compare
To Synthesize--to combine, generalize, formulate something new
To Apply--to use, apply, solve problems
To Appreciate--to show interest, attitude, attention

through the page containing the illustration. This opening of the context to consideration admittedly opened as well the possibility that the objective would be written for the whole page or section, which would certainly negate its validity as an illustration objective. However, to remove the illustration entirely from its context was to assure a reduction in the validity of the objective. An illustration is presumably designed to be integral to a particular phase in the sequential development of a concept and thus derives its meaning for the student from its position in the sequence, i.e., its context. To consider the objective of an illustration in isolation from its context is to distort, if not invalidate, its status as a textbook illustration. Further, sans context, there is no way of establishing the status of the learner's knowledge of the subject as he encounters the illustration. The rationale as presented to the teachers is given in Table 20.

A related question was that of the caption. Was it to be considered a part of the context or part of the illustration? It was decided that a caption is instructionally a part of the illustration and hence should be so considered in writing the objective. Subjective assessments of caption alone or picture alone almost always confirmed their interdependence. The publishers' intent seemed clear as well, for the caption is typically set apart from its verbal context, is of different type font or size than the context, and bears a pronounced proximity relationship to the picture. Picture plus caption (if any) was thus considered to constitute an illustration, the instructional unit for which objectives were to be written. Because of occasional ambiguities, the area defined as the illustration was outlined in blue.

With reference to the third question, it was decided to make two scales--one for categorizing the type of learner behavior and the other for assessing its difficulty level. One of the assumptions of the Bloom taxonomy (2) is its hierarchical structure from Knowledge, category 1, to Evaluation, category 6. Each category is assumed to require prior competence in all preceding categories. It follows that category 1 behavior is the simplest on the "ladder" of learning and category 6 behavior the most difficult, at least in terms of its prerequisites. This characteristic of the taxonomy was at first considered by the staff to facilitate reliable categorization. The user began at category one, bottom rung of the ladder, and went up the rungs to the appropriate stopping point. Further, some research on the question tends to substantiate the hierarchical character of at least part of the taxonomy (1)(18). However, after much rearranging and redefining of categories, the staff came to the conclusion that while the Bloom taxonomy could be employed to construct items that would bear the appropriate hierarchical relation, there was no intrinsic or necessary behavioral hierarchy among the categories, i.e., a Synthesis objective, category 5 could (and perhaps usually would) be written at a higher level than an Application objective, category 3, but need not always be. For example, a generalization (Synthesis) from a laboratory experiment could be dependent on prior completion of a given laboratory procedure (Application). Conversely, the completion of a given laboratory procedure (Application) could be dependent on the prior planning (Synthesis) of that procedure. It was thus possible to conceive of Application and Synthesis objectives in either hierarchical order. Or again, an Analysis process, category 4, rather than always following categories 1, 2, and 3, can be conceived as leading to Knowledge, category 1, or Comprehension, category 2, or Application, category 3. Consequently, the objective taxonomy for this study makes no reference to a possible hierarchical characteristic of objectives but seeks only to delineate behavioral types. The hierarchical aspect was reserved for a subsequent scale.

Level of Involvement Scale

As suggested above, while the Bloom taxonomy was assumed to be generally hierarchical, adequate hierarchical separation of categories required the superimposition of restrictions on the use of categories, e.g., in conceiving of Analysis items, category 4, one deliberately selected from among the possible levels of analytical behavior those that were at a higher level than Knowledge, Comprehension, or Application behavior or that demonstrably required prerequisite abilities at the three lower levels. Consequently, the objective was written to fit both the level and type specified by the taxonomy.

To isolate level considerations from type considerations a five-point scale was employed, Figure 10, to indicate the degree of the student's involvement. The scale ranged from quite limited (level 1) to quite extensive (level 5). As initially conceived, this scale was to measure level of difficulty. However, it became apparent that objectives in the Appreciation category could not appropriately be distributed along a difficulty scale. Consequently, a level of involvement scale was substituted. Degree of involvement was explicated as the duration and intensity of the student's involvement in meeting a given objective. The teacher was to make this judgment for each objective he had written, and his frame of reference for relative involvement was to be the pool

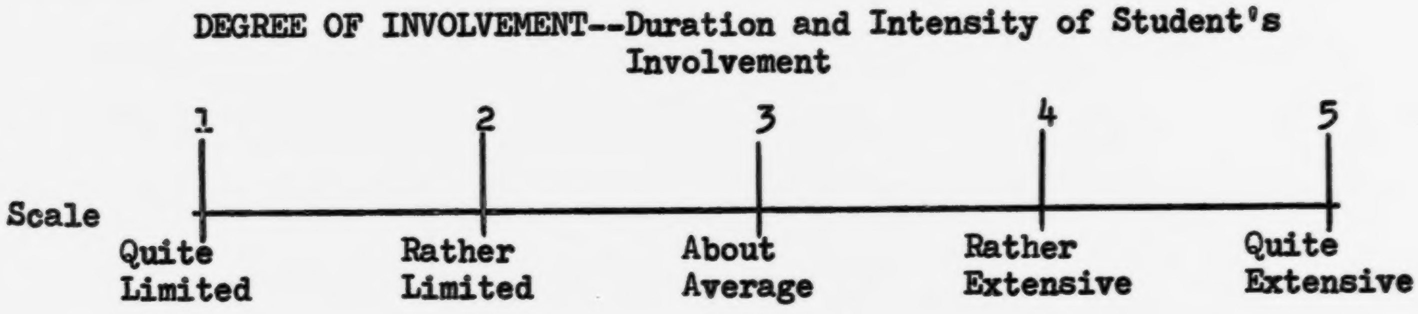

DEGREE OF INVOLVEMENT--Duration and Intensity of Student's Involvement
1
2
3
4
5
Scale
Quite Limited
Rather Limited
About Average
Rather Extensive
Quite Extensive

Figure 10. Level of Involvement Scale for Educational Objectives

of approximately 100 objectives he had written. The two criteria for judging involvement were as follows:

1. Student criterion, which was defined as the amount of time and energy the student might spend meeting the objective.

2. Information criterion, which was defined as the amount, novelty, and complexity of information associated with meeting the objective.

Both criteria were to be used, although it was felt that the first would be a function of the second, i.e., the amount of time and energy a student would spend would be directly related to the amount, novelty, and complexity of the information required.

Judging Procedures

It was a part of the initial plan that teachers would be the judges of which objectives the sample of illustrations could best serve. Publishers, art editors, subject-matter editors, and authors were conceived as being less well prepared than the classroom teacher for this task. Subsequent work with teachers and discussions with publishers would suggest a more accurate analysis--no one is demonstrably an authority in assigning educational objectives to particular illustrations, or, at least, there is considerable lack of consensus among authorities on the subject. It remains probable, however, that among teachers can be found the most valid judges of the behavioral objectives that would be most appropriate for illustrations as used by their eighth-grade students in particular subject matters.

Teacher viewpoints were determinative from the outset of planning for the objective taxonomy because a former elementary social studies and English teacher and a secondary science teacher were on the research staff. Further, the initial taxonomy was tested with a sample of 15 eighth-grade teachers before the revised instrument was employed with 24 final teacher judges.

It was anticipated that teachers would vary somewhat in their judgments of the most appropriate objective for an illustration. Control of the potential variation could have been maximized by insisting that the several teachers achieve a consensus; however, the human engineering task of achieving a consensus for each of 787 illustrations would have been impractical, and the results might not have been as valid as independent judgments. Consequently, the chosen strategy was to elicit three independent estimates of objectives for each illustration from which still another judge would pick the most appropriate.

Selection of judges. Adequate random sampling of teacher opinion would have necessitated a teacher sample of impractical size. Further, the intent was to sample only expert teachers who could appropriately be considered judges of instructional materials in their own fields. The method of selecting the three independent judges was intended to permit, if not maximize, diversity among the objectives from which the final judge was to choose. The teachers were selected from three school systems: large (approximately 100,000 students), medium (approximately 30,000 students), and small (approximately 3,000 students).

The school systems were selected from northern, central, and southern Indiana. See the list of teachers and school systems in Appendix G. Within each school system three different schools were sampled. All teachers were chosen by superintendents or administrative personnel authorized by the superintendents. Selection criteria were:

1. Eighth-grade teacher in the subject matter
2. Judged to be an expert classroom teacher
3. At least two years of teaching experience

Teachers in each school system were distributed by subject matter across schools as shown in Table 21. Choice of schools within a system was made by superintendents. For the two smaller school systems the superintendents had very little choice because most of the junior high schools in the system were needed. For the larger system an attempt was made to include a representative range in the size of the schools and the age of the schools. In all cases the availability of excellent teachers in the appropriate combinations had considerable influence on school choice.

TABLE 21. DISTRIBUTION OF TEACHERS ACROSS SUBJECT MATTER IN EACH SCHOOL SYSTEM

School	English	History	Mathematics	Science	Total
A		1	1	1	3
B	1	1		1	3
C		1	1		2
Total	1	3	2	2	8

There were thus eight teachers from three schools in each of three school systems, or 24 teachers in all.

As can be seen, sampling was controlled for two of the possible sources of variation--subject matter taught and size of school system. Subject matter was distributed across schools with no more than one history teacher, for example, from any school.

The apparent asymmetrical distribution of teachers across subject matter, was designed to approximate the distribution of illustrations across subject matter as shown in Table 22. Each teacher judged approximately 100 illustrations (87-115 range). This procedure was chosen primarily on the basis of practical considerations. Feedback from teachers participating in the pretest indicated that a sample of 100 illustrations was about as large as a teacher in service could be expected to deal with competently in a limited period of time (about two weeks).

TABLE 22. DISTRIBUTION OF TEACHERS (WITHIN ONE SYSTEM) AND ILLUSTRATIONS ACROSS SUBJECT MATTER

	English	History	Mathematics	Science
Sample of teachers	1	3	2	2
Sample of illustrations	95	278	184	230
Illustrations judged per teacher	95	87,90,101	92	115

In sum, each teacher wrote objectives for about 100 illustrations, so that the eight teachers in one system wrote objectives for the whole sample of 787 illustrations, which procedure was replicated in the three school systems, thus producing three objectives for each illustration.

Instructions to judges. For the implementation of the above design, an adequate briefing for each teacher was essential. Instructions were incorporated in an 18-page document, Appendix H. This included the following:

1. description of the project
2. description of the task
3. definition and examples of student behavioral objectives
4. rationale for choice of objective (Table 20)
5. objective taxonomy (Table 19)
6. examples of illustrations and possible objectives
7. discussion of potential problems in applying the taxonomy
8. description of Level of Involvement Scale (Figure 10)
9. summary of instructions
10. sample tally sheet

For item six above, sample sets of illustrations (copied from textbooks) together with matching objectives were supplied for each subject area. There was a sample illustration and objective for each of the five types of objectives (Appendix H).

Members of the research team met with the eight teachers from each school system for a one and a half hour briefing session. Instruction for using the taxonomy were discussed section by section. Questions were entertained and answered. At the close of the briefing session each teacher received the textbooks assigned to him (her) and was supplied tally sheets (Appendix H) for posting objectives, objective types, and objective levels. The selected illustrations in each book had been tabbed, numbered, and circled in blue.

The above procedures produced for each illustration three objectives which were categorized by type and by level. These data permitted statistical treatment of such tabulations as degree of agreement among teacher judges, patterns of judge choices, and possible associations of choices with other factors. However, for some purposes a single "most appropriate" objective for each illustration was necessary. Consequently, still other judges made the final choice of one objective considered most appropriate for each illustration from among the three. See Appendix I for the objective chosen for each illustration.

Criteria for the final choice were as follow:

1. Same criteria that the other teachers had employed (described in Table 20 and fully presented in Appendix H);
2. If two or more objectives met the first criterion equally well, the most clearly phrased one was chosen;
3. If two or more objectives met both criterion one and two, a random selection was made.

Judges making this choice were two members of the research staff. The former teacher of social studies and English judged English and history; the secondary science teacher judged science and mathematics. Though potentially biasing, the use of staff judges was thought to add a degree of validity not otherwise possible. In the first place, their choices were limited to the objectives written independently by the practicing teachers. Secondly, they were uniquely able to bring to bear criteria stemming from the staff deliberations leading to the taxonomy itself and the rationale for applying it to the sample. Whatever the adequacy of the taxonomy might be, the staff judges were the most authoritative in its interpretation.

Reliability and validity of judging. Inter-judge reliability estimates could have been computed, but because no estimate of the validity of the judgments was available, undue attention to their reliability seemed inadvisable. Objectives on which teachers were in complete disagreement may all, upon empirical test, prove to be appropriate for the illustrations. Contrariwise, objectives on which judges were in total agreement may prove to be inappropriate for the illustrations.

Consequently, only the frequency distribution of objectives across the five types is given for each judge, Table 23. Each group of three judges shown in the table judged the same group of illustrations.

Chi-Square analysis of the frequencies from each group of three judges showed six of the eight groups to be different by a statistically significant amount ($p < .02$). For the whole sample of 787 illustrations, the judges were in partial agreement (two of three) as to the type of objective assigned to 54.9 per cent of the illustrations, but were in total agreement (three of three) for only 14.1 per cent of the illustrations and were in total disagreement (none of three) for 31.0 per cent of the illustrations.

Possible sources of these observed differences were discussed earlier (section on Pretest of Objective Taxonomy) and included the following factors:

TABLE 23. FREQUENCY DISTRIBUTION OF OBJECTIVE TYPES BY JUDGE AND SUBJECT MATTER

Subject	Judge	Objective types				
		Knowledge	Analysis	Synthesis	Application	Appreciation
English teachers	1	28	7	4	11	45
	2	15	21	6	29	24
	3	20	30	16	16	13
History teachers	1	11	29	32	2	13
	2	21	35	24	0	7
	3	25	23	15	11	13
	4	33	23	11	6	28
	5	44	20	23	3	11
	6	6	24	48	1	22
	7	11	38	24	5	12
	8	16	28	19	1	26
	9	19	26	20	3	22
Mathematics teachers	1	13	22	24	26	7
	2	10	27	18	24	13
	3	15	22	12	34	9
	4	20	20	19	22	11
	5	24	21	7	33	7
	6	30	31	11	18	2
Science teachers	1	33	21	22	14	25
	2	41	15	26	4	29
	3	25	23	38	4	25
	4	27	23	14	10	41
	5	24	17	18	22	34
	6	21	27	26	24	17

1. the taxonomy, particularly the delineation of categories;
2. the rationale and procedure for applying the taxonomy to the sample;
3. the qualifications of the judges;
4. the characteristics of the illustrations judged.

In retrospect it must be said that while the pretest taxonomy, Table 16, may have suffered from inadequate delineation regarding 1 and 2 above, the final taxonomy, Table 19, may have so elaborated these aspects that for some teacher judges the affect was to reduce understanding of the task or at least to make it appear unduly complex. Thus, while the final taxonomy was more explicit with regard to factors 1 and 2, the effect on reliability might not always have been positive.

Factor 3, qualifications of judges, was discussed extensively at the beginning of the previous section, Judging of Objectives. It can be reasserted here that, for the task assigned, there are no known judges that are more authoritative than teachers. The designers, editors, and authors of the books are likely the authorities on intended objectives, but the teachers are the more likely authorities on the appropriateness of objectives as actually used with eighth-grade students. The most precise statement that can be made is that no authority can be verified until illustrations are very widely tested as used by teachers in the classroom and as encountered and responded to by students in the normal course of their study. The research literature provides some hints in this regard, but few definitive statements can be made associating particular types of illustrations with particular educational objectives (student behaviors) at the junior high school level.

The objectives suggested for certain illustrations by authors and editors in teachers' editions were examined, but the irregularity of their occurrence and the inconsistency of their content make comparisons with the teacher objectives impossible.

Factor 4, characteristics of the illustrations judged, leads first to a comparison of illustrations with other "objects" which have been classified by judges using Bloom's taxonomy or a modification of it. The "objects" commonly reported are test items. For example, McGuire (12) reports total agreement among three judges for 67 per cent of 683 items, and Stoker and Kropp (18) report total agreement among five judges for 11 of 36 items. Apart from the apparent disparity of "objects" classified, a disparity of task exists as well, for the task in this study consisted of both the judging of the illustrations and the writing of objectives.

In addition to this lack of comparability with other studies is the lack of substantial information regarding the singularity or multiplicity of objectives that particular illustrations might serve. There seems to be no basis for assuming that instructional illustrations are univocal (or unequivocal) regarding instructional objective. Because of the apparent diversity of illustrations (subject matter, physical types, caption types), it might be expected that some would be relatively univocal while others would be multivocal. This aspect of the study is one of those most obviously requiring additional and more intensive research work.

Scaling Objective Data

Although it was initially planned that there be only one objective type scale, subsequent developments led to the construction of five scales for the purpose of ordering the data for the Chi-Square analyses.

The first scale, Table 24, was intended to classify the illustrations according to the amount of agreement among the teacher judges as to the most appropriate objective type.

TABLE 24. OBJECTIVE SCALE 1: TYPE AGREEMENT

Point	Description
1	No agreement (none of three agreed)
2	Partial agreement (two of three agreed)
3	Total agreement (three of three agreed)

The frequencies found for this scale are given in Chapter VII, Results, along with analyses of the relations between this scale and the other scales--physical type, subject-matter type, and verbal modifier type.

The second scale was intended to classify illustrations according to the pattern of objective types assigned them by the three teacher judges. As shown in Table 25, it was practical to classify by objective type only those illustrations for which teachers were in partial or total agreement as to type. All other illustrations were lumped at Point 11.

TABLE 25. OBJECTIVE SCALE 2: TYPE PATTERN

Point	Objective type	Judges agreeing
1	Knowledge	Three
2	Analysis	Three
3	Synthesis	Three
4	Application	Three
5	Appreciation	Three
6	Knowledge	Two
7	Analysis	Two
8	Synthesis	Two
9	Application	Two
10	Appreciation	Two
11	Any	None

The third scale classified each illustration according to the type of the one objective which was chosen as most appropriate, "best," by staff judges from among the three objectives written by the teacher judges. (Judging procedure described in a preceding section.) As shown in Table 26 the scale includes the five types of objectives which constituted the Objective Taxonomy, Table 19.

TABLE 26. OBJECTIVE SCALE 3: BEST TYPE

Point	Objective type
1	Knowledge
2	Analysis
3	Synthesis
4	Application
5	Appreciation

While the first three scales dealt with objective type, the fourth and fifth scales dealt with the difficulty level of the objectives. As shown in Table 27, scale four was to classify illustrations according to the amount of agreement among teacher judges as to the level of the objective, i.e., level of involvement as indicated in Figure 10.

TABLE 27. OBJECTIVE SCALE 4: LEVEL AGREEMENT

Point	Description
1	No agreement (none of three agreed)
2	Partial agreement (two of three agreed)
3	Total agreement (three of three agreed)

The fifth scale was to classify each illustration objective according to the "best" level, which was in actuality the mathematical average of the levels (1 to 5) assigned by the teacher judges. As shown in Table 28, the five involvement levels were given intervals into which the averaged levels could be placed. For example, if three teachers chose levels, 2, 2, and 3 for an illustration, the average level of 2.3 was within the interval for Point 2, Rather Limited Involvement.

TABLE 28. OBJECTIVE SCALE 5: BEST LEVEL

Point	Intervals	Level of involvement
1	1.0-1.4	Quite limited
2	1.5-2.4	Rather limited
3	2.5-3.4	About average
4	3.5-4.4	Rather extensive
5	4.5-5.0	Quite extensive

The distribution of the sample of illustrations across each of the objective scales is given in Chapter VII, Results, as are the Chi-Square tests of the relation between each objective scale and the other scales--subject matter, physical type and verbal modifier type.

CHAPTER VI

VERBAL MODIFIER TAXONOMY

Definitions

Although initially conceived of as a taxonomy of captions, this taxonomy evolved into a taxonomy of verbal modifiers of illustrations. As such it includes not only captions but labels, legends, and some titles. In the language employed in the Units of Analysis section of Chapter III, the taxonomy of verbal modifiers dealt with v_a, the verbal elements adjacent to the pictorial unit, (usually captions and sometimes titles), and v_w, the verbal elements within the pictorial unit (usually labels and sometimes titles). Phrased yet another way, this taxonomy included all verbal elements within an area defined as an illustration.

As discussed earlier, in Chapter III, one of the most persistent problems was translating such common terms as caption, title, and label into operational terms. The definitions for caption, title, and label given below are those initially conceived. They apply to most verbal units in most books; however, there were a number of exceptions in the sample.

Caption is a verbal unit meeting the following criteria:

1. stated as a complete sentence(s);
2. set apart from the text by location (adjacent to the pictorial unit) and by type (different font or size than the text);

3. referred to the entire pictorial unit, although parts of the caption could refer to parts of the pictorial unit.

Title is a verbal unit meeting the following criteria:

1. stated as sentence fragment(s) or word(s);
2. could be either within or adjacent to the pictorial unit;
3. referred to the whole pictorial unit.

Label is a verbal unit meeting the following criteria:

1. stated as sentence fragment(s) or word(s);
2. located within the pictorial unit;
3. referred to part of the pictorial unit.

Occasional units which did not wholly meet these criteria were such as the following:

1. Captions (complete sentences) which were located like labels (within the pictorial unit) and functioned as labels (referring to only part of the pictorial unit);

2. Labels (words or sentence fragments) which were located like captions (adjacent to the pictorial unit) and functioned like captions (referring to the whole pictorial unit);

3. Titles (referring to the whole pictorial unit) which were like captions (composed of a complete sentence).

Because the three criteria initially employed in the definitions could not be consistently applied in combination, it was decided to increase objectivity by using the criteria separately as follows:

1. Sentences (usually captions)

    Declarative, Interrogative, etc.

2. Non-sentences

Referring to whole pictorial unit (usually titles)

Referring to part of pictorial unit (usually labels)

Note that the final taxonomy was structured in terms of the above explicit criteria, and no attempt was made to employ the terms caption, title, or label in a definitive sense.

The first scale, Table 29, was to indicate the presence or absence of the two primary types of verbal modifiers, sentences and non-sentences. This scale made possible statements about the frequency of occurrence of certain verbal modifiers in relation to objective types, physical types, and subject-matter types.

TABLE 29. SCALE 1: BASIC TYPES OF VERBAL MODIFIERS

Point	Description
1	No verbal modifier
2	Sentence(s) only
3	Non-sentence(s) only
4	Both sentence(s) and non-sentence(s)

It should be noted that the term verbal element as defined in Chapter III, included both verbal and numerical symbols. Hence, the term verbal modifier was here used to include numerical sentences (equations) and numerical non-sentences (single digits or any combination other than an equation).

Sentence Scales

Sentences were further categorized by quantity and by type. The 10-point quantity scale, Table 30, ranges from 0 to over 34 sentences. The scale intervals, being smaller where frequencies were known to be greater and vice versa, were arranged with reference to the sample.

TABLE 30. SCALE 2: QUANTITY OF SENTENCES PER ILLUSTRATION

Point	Sentences
1	0
2	1
3	2
4	3
5	4
6	5-6
7	7-10
8	11-14
9	15-21
10	22-34+

The typical caption, of course, does not approach 34 sentences (category 10) or even 10 sentences (category 7). However, one history book and one or two science books consistently placed several paragraphs of verbal material in association with certain pictorial units. Because these met the criteria (proximity relation to the picture and different type font or size than text), they were included as the "caption" part of the illustration.

The 16-point scale for sentence types and patterns, Table 31, indicated the presence of the four types (declarative, interrogative, imperative, and other) either singly or in any combination. It was anticipated that these sentence types might be differentially associated with different subject matter, different instructional objectives, and perhaps even with different physical types of illustrations.

TABLE 31. SCALE 3: SENTENCE TYPES AND PATTERNS OF TYPES

Point	Description
1	None
2	Declarative
3	Interrogative
4	Imperative
5	Other (Exclamatory and Mathematical)
6	Declarative and Interrogative
7	Declarative and Imperative
8	Declarative and Other
9	Interrogative and Imperative
10	Interrogative and Other
11	Imperative and Other
12	Declarative, Interrogative, and Imperative
13	Declarative, Interrogative, and Other
14	Declarative, Imperative, and Other
15	Interrogative, Imperative, and Other
16	Declarative, Interrogative, Imperative, and Other

The "Other" category was compounded of exclamatory sentences and mathematical sentences. Mathematical sentences (equations) were included not only because numerical elements had been classed together with verbal elements from the outset but also because captions and exercises in mathematics textbooks frequently intermixed verbal sentences and mathematical equations. Mathematical sentences were put in combination with exclamatory sentences because neither occurred with sufficient frequency for statistical purposes. The product is truly a miscellaneous or "other" category.

Non-sentence Scales

The non-sentence verbal and numerical units were likewise categorized into two scales, one quantitative and the other by type and pattern. The 10-point quantitative scale included the range from 0 to over 50 units per illustration, Table 32. In some instances, primarily in maps and complex diagrams, the quantity ran well over 50.

TABLE 32. SCALE 4: QUANTITY OF NON-SENTENCES PER ILLUSTRATION

Point	Non-sentences
1	None
2	1
3	2
4	3-4
5	5-6
6	7-8
7	9-12
8	13-21
9	22-41
10	42-50+

The 8-point scale for type and patterns of types of non-sentence modifiers, Table 33, includes three types (titles, labels, and legends) as well as the possible combinations of these types.

TABLE 33. SCALE 5: TYPES AND PATTERNS OF NON-SENTENCE MODIFIERS

Point	Description
1	None
2	Title(s) Only
3	Label(s) Only
4	Legend(s) Only
5	Title(s) and Label(s)
6	Title(s) and Legend(s)
7	Label(s) and Legend(s)
8	Title(s), Label(s), and Legend(s)

The terms title, label, and legend, have been employed in Table 33 for convenience only. Operationally, they as a group were the units that did not meet the requirements of a sentence. Of these, the units called "titles" in the table were verbal modifiers which referred to the whole pictorial unit, while those called "labels" were verbal modifiers which referred to part of the pictorial unit. "Legends" were those verbal modifiers which, regardless of reference, contained a key, such as a brown rectangle beside the words "Northwest Territory" to designate the reference to a portion of a map.

Other Possible Scales

The verbal modifier scales included in this study were those which were judged to be most instructionally relevant, but several which met this criterion were eliminated because of their subjectivity. These scales and others not considered by the staff may in future research be shown to be determinative of learning and as such may become operationally defined in terms of learner behavior. The several types of scales considered but discarded are mentioned briefly in what follows.

Relative proximity scale. In a sense the concepts v_w, verbal elements within the pictorial unit, and v_a, verbal elements adjacent to the pictorial unit, are points on a proximity scale. The next logical point would be those verbal elements that are farther away from the pictorial unit, i.e., those in the textual material. To have included textual material would have involved a semantic analysis of all text areas within a page or two of the illustration, and consequently was not only a sizeable task but one full of definitional "greys." Further, such verbal units were technically not a part of the illustration and hence not a prime concern of this study.

Instructionally, the textual material outside the illustration, but referring to it directly or indirectly, is of obvious importance and consequently should be studied.

Type of reference scale. It was observed that verbal modifiers referred to that which they modified (pictorial unit) in different ways. There were, for example, such direct references in text or caption as "the illustration above" and "the map." There were also mechanical references, such as "Figure _____" and page _____." Design elements, such as arrows or connecting lines, were used for reference as well. Other verbal units, while making no direct reference to the pictorial unit, did appear indirectly related by way of a kind of parallelism between the verbal statement and the pictorial statement.

Instructional function scale. This scale would probably be the least objective and most significant type of scale from an instructional point of view. Verbal modifiers appeared to serve many purposes: name, describe, explain, interpret, restate, exemplify, point to, ask questions about, give directions regarding, etc. These purposes are overlapping and ill-defined as stated but should, in the opinion of the staff, be the object of intensive definitional and experimental work.

Judging Procedures

Staff judges tabulated for each illustration the number of associated sentences in each of the four categories and the number of associated non-sentences in each of the three categories. One judge covered the science and mathematics illustrations; while the other covered the English and history. Prior to final judging of the sample there were two pretests. Each judge categorized the same sample of 10-20 illustrations independently, then compared and reconciled their differences. On the basis of two such pretests the procedure was refined. The final procedure is given in Appendix J.

Sentences were identified by using the common grammatical definition, except that beginning and end punctuation was overlooked so long as a complete thought was given (subject and predicate). The sentences were tabulated as being declarative, interrogative, imperative, or exclamatory, again following standard grammatical definitions. Mathematical sentences were those combinations of numerical symbols which comprised an equation, i.e., that in a sense expressed a complete mathematical thought.

Non-sentences were tabulated according to whether they referred to only part of the picture (usually labels), or referred to the whole picture (usually titles), or, regardless of reference, included a key (usually legends).

There were two major sources of pretest disagreement between judges. One was the kind of illustration which included pictured objects that were in part verbal, such as a picture of a book cover, a picture of a labelled bottle, or a picture of a building with a sign. It was decided to include such verbal units so long as each word was fully discriminable. A picture of a theater, for example, whose marquee only suggested its name (partially obliterated letters), was not counted.

The other area of disagreement was that of the degree to which complexly labelled illustrations should be analyzed. On a map, for example, was each city, state, river, latitude, longitude, lake, mountain, etc. to be counted? In general it was decided to count each such unit, although, as indicated in the procedure (Appendix J), certain redundancies were omitted (labels at both ends of a meridian) and certain closely associated designations (an event and its date) were combined and counted as one.

Among the possible research questions suggested by these scales are the following:

1. Which type of sentence most efficiently directs attention to the relevant elements (cues) in an illustration? (Eye-movement analysis)

2. Which type of sentence involves the student in a longer transaction with an illustration?

3. In the case of several sentences directed toward an illustration, what is the pattern of the student-illustration transaction--all sentences and then all picture, sentence-picture-sentence-picture, or other? Are different patterns associated with different learning outcomes?

4. For the design of a program or system, what criteria should apply to quantifying, sequencing, and interrelating verbal and pictorial units?

5. What factors reduce error and time in associating labels and their referents--proximity of label to referent, connecting lines or arrows, label adjacent to the referent versus superimposed upon it, logical sequencing of labels versus referent sequencing, etc.?

6. Is the frequency and duration of attention to a picture (eye-movement) a function of the proximity of the related verbal units--greatest for verbal units within, slightly less for verbal units adjacent, and least for verbal units outside the illustration?

7. Can a variety of instructional roles be specified for verbal elements in relation to pictorial elements, and can these be operationally defined and experimentally assessed?

8. Is the number of sentences necessary to elicit the desired response relative to an illustration directly proportional to the equivocality (multivocality) of the illustration, i.e., is it the case that the greater the multivocality, the greater the number of delimiting sentences necessary? Multivocality might be pre-determined by the number of statements that subjects might make about the illustration alone.

The above questions are intended for research stimulation rather than rigorous, literature-based, research specification.

The distribution of the sample of illustrations across each of the verbal modifier scales is given in Chapter VII, Results, as are Chi-Square tests of the relation between each verbal modifier scale and the other scales--subject matter and objective type.

CHAPTER VII

RESULTS

Introduction

Chi-Square analyses were made to test the independence of each pair of scales. From the total of 22 scales (1 subject-matter scale, 11 physical type scales, 5 objective type and level scales, and 5 verbal modifier scales), there resulted a total of 231 analyses. Of these, about one third were chosen, as described later, for particular attention in this report.

First, each of the 22 scales is presented separately to show the frequency and percentage of the sample of illustrations associated with each point on the scales (percentages omitted for scales over 10 points long). Some of this information, lost in the Chi-Square tables because of combined categories, may be of general reader interest. It indicates, for example,

that 23.4% of the sample were mathematics illustrations;

that the two most frequent objectives for the illustrations in the sample were Knowledge and Analysis;

that 43.8% of the illustrations were Free Form or Amoeboid in configuration;

that 40.2% had no verbal or design elements within the pictorial unit;

that 45.1% of the sample had one color but only 3.9% were full color;

that for 22.5% the photographic encoding medium was used;

that realistic (55%) and diagrammatic (35.7%) styles predominated;

that 19.4% of the illustrations had one or more sentences as the only verbal modifiers; and

that 26.4% were accompanied by both titles and labels.

TABLE 34. FREQUENCIES AND PERCENTAGES FOR SEPARATE SCALES

	Frequencies	Percentages
SUBJECT MATTER SCALE		
1. English	95	12.1
2. History	278	35.3
3. Mathematics	184	23.4
4. Science	230	29.2
Total	787	100.0
OBJECTIVE TYPE SCALES*		
1. Objective Type Agreement		
1. None	244	31.0
2. Partial	432	54.9
3. Total	111	14.1
Total	787	100.0
2. Objective Type Pattern		
1. Three Knowledge**	27	
2. Three Analysis	22	
3. Three Synthesis	12	
4. Three Application	24	
5. Three Appreciation	26	
6. Two Knowledge***	104	
7. Two Analysis	107	
8. Two Synthesis	83	
9. Two Application	53	
10. Two Appreciation	84	
11. No Agreement	245	
Total	787	
3. Best Objective Type		
1. Knowledge	203	25.8
2. Analysis	194	24.7
3. Synthesis	138	17.5
4. Application	94	11.9
5. Appreciation	158	20.1
Total	787	100.0

*See Chapter V for full description of scales.

**Three of three judges agreeing.

***Two of three judges agreeing.

TABLE 34 (Continued)

Objective Type Scales (cont.)	Frequencies	Percentages
4. Objective Level Agreement		
1. None	261	33.2
2. Partial	442	56.2
3. Total	84	10.6
Total	787	100.0
5. Best Objective Level		
1. Quite limited	38	4.8
2. Rather limited	255	32.4
3. About average	317	40.3
4. Rather extensive	161	20.5
5. Quite extensive	16	2.0
Total	787	100.0
PHYSICAL TYPE SCALES*		
1. Area (sq. in.)		
1. 0-4	119	15.1
2. 5-8	95	12.1
3. 9-12	196	24.9
4. 13-17	106	13.5
5. 18-25	141	17.9
6. 26-40	87	11.0
7. ~~41-80~~	39	5.0
8. 81-110	3	0.4
9. 111-140+	1	0.1
Total	787	100.0
2. Framing		
1. Actual, distinct line	46	5.8
2. Actual, abrupt edge	194	24.8
3. Actual, either with bleed	166	21.2
4. Bleed all four sides	1	0.1
5. Combined actual and implied	10	1.3
6. Implied with bleed	40	5.1
7. Implied	306	38.9
8. Mixed	24	2.8
Total	787	100.0
3. Configuration		
1. Square	22	2.8
2. Horizontal rectangle	208	26.8
3. Vertical rectangle	116	14.7
4. Irregular rectangle	13	1.7
5. Circular & Ellipsoid	5	0.6
6. Free-form, Amoeboid	345	43.8
7. Other	35	4.3
9. Mixed	43	5.3
Total	787	100.0

*See Chapter IV for full description of scales.

TABLE 34 (Continued)

Physical Type Scales (cont.)	Frequencies	Percentages
4. Position*		
1. A	35	
2. B	14	
3. C	20	
4. D	47	
5. E	22	
6. F	39	
7. AB	32	
8. AD	78	
9. BC	20	
10. BE	15	
11. CF	66	
12. DE	39	
13. EF	34	
14. ABC	12	
15. ABD	1	
16. ABE	1	
17. ADE	1	
18. BCE	0	
19. BCF	2	
20. BDE	0	
21. BEF	1	
22. CEF	4	
23. DEF	21	
24. ABCD	1	
25. ABCE	0	
26. ABCF	0	
27. ABDE	122	
28. ABEF	1	
29. ADEF	5	
30. BCDE	0	
31. BCEF	83	
32. BDEF	0	
33. CDEF	2	
34. ABCDE	2	
35. ABCDF	0	
36. ABCEF	0	
37. ABDEF	1	
38. ACDEF	0	
39. BCDEF	5	
40. ABCDEF	21	
41. Full Page	11	
42. Diagonal	1	
43. Double Page	28	
Total	787	

*See Figure 8 in Chapter IV for interpretation of A, B, C, etc. positions.

TABLE 34 (Continued)

Physical Type Scales (cont.)	Frequencies	Percentages
5. Elements		
1. Pictorial	316	40.2
2. Pictorial & verbal	245	31.1
3. Pictorial & design	203	25.8
4. Pictorial, verbal & design	23	2.9
Total	787	100.0
6. Chroma		
1. Non-chromatic	307	39.0
2. Mono-chromatic	355	45.1
3. Duo-chromatic	14	1.8
4. Tri-chromatic	10	1.3
5. Poly-chromatic	48	6.1
6. Full-chromatic	31	3.9
9. Mixed-chromatic	22	2.8
Total	787	100.0
7. Achroma		
1. Non-achromatic	75	9.5
2. Mono-achromatic	311	39.5
3. Duo-achromatic	90	11.4
4. Tri-achromatic	6	0.8
5. Poly-achromatic	136	17.3
6. Full achromatic	143	18.2
9. Mixed achromatic	26	3.3
Total	787	100.0
8. Encoding Media		
1. Photographic	177	22.5
2. Artistic two-dimensional	360	45.6
3. Mechanical	215	27.3
4. Mixed media	35	4.6
Total	787	100.0
9. Encoding Style		
1. Realistic	433	55.0
2. Cartoon	39	5.0
3. Diagrammatic	280	35.7
4. Design	2	0.3
5. Impressionistic	2	0.3
9. Mixed style	31	3.7
Total	787	100.0

TABLE 34 (Continued)

Physical Type Scales (cont.)	Frequencies	Percentages
10. Information Level		
1. Natural environment, full shading, full dimensionality, full interior detail	327	41.5
2. In limbo, full shading, full dimensionality, full interior detail	39	5.0
3. In limbo, limited shading limited dimensionality, full interior detail	106	13.5
4. In limbo, no shading limited dimensionality, limited interior detail	269	34.2
5. In limbo, no shading, no dimensionality, no interior detail	1	0.1
9. Mixed level	45	5.7
Total	787	100.0
11. Unification		
1. Fully unified	659	83.7
2. Mostly unified	104	13.2
3. About as unified as separated	22	2.8
4. Mostly separated	2	0.3
5. Fully separated	0	0.0
Total	787	100.0
VERBAL MODIFIER SCALES*		
1. Types of Verbal Modifiers		
1. None	43	5.5
2. Sentences	153	19.4
3. Non-sentences	177	22.5
4. Both	414	52.6
Total	787	100.0

*See Chapter VI for full descriptions of scales.

TABLE 34 (Continued)

Verbal Modifier Scales (cont.)	Frequencies	Percentages
2. Sentence Quantity		
1. None	218	27.8
2. One	143	18.2
3. Two	147	18.7
4. Three	79	10.0
5. Four	49	6.2
6. 5-6	55	7.0
7. 7-10	35	4.4
8. 11-14	27	3.4
9. 15-21	22	2.8
10. 22-34+	12	1.5
Total	787	100.0
3. Sentence Pattern		
1. None	218	
2. Declarative	302	
3. Interrogative	11	
4. Imperative	28	
5. Other (Exclamatory & Math)	2	
6. Declarative & Interrogative	73	
7. Declarative & Imperative	51	
8. Declarative & Other	6	
9. Interrogative & Imperative	17	
10. Interrogative & Other	1	
11. Imperative & Other	2	
12. Declarative, Interrogative & Imperative	57	
13. Declarative, Interrogative, & Other	5	
14. Declarative, Imperative, & Other	4	
15. Interrogative, Imperative, & Other	0	
16. All four types	10	
Total	787	
4. Non-sentence Quantity		
1. None	196	24.9
2. One	140	17.8
3. Two	85	10.8
4. Three, Four	81	10.3
5. Five, Six	60	7.6
6. Seven, Eight	51	6.5
7. 9-12	56	7.1
8. 13-21	52	6.6
9. 22-41	34	4.3
10. 42+	32	4.1
Total	787	100.0

TABLE 34 (Continued)

Verbal Modifier Scales (cont.)	Frequencies	Percentages
5. Non-sentence Pattern		
1. None	196	24.9
2. Title	131	16.7
3. Label	220	28.0
4. Legend	0	0.0
5. Title & label	208	26.4
6. Title & legend	1	0.1
7. Label & legend	9	1.1
8. All three types	22	2.8
Total	787	100.0

In the statements of results which follow, the expression "the frequency of occurrence of variable X is significantly associated with variable Y" should be taken to mean that the null hypothesis that variable X is independent of variable Y is rejected.

A significance level of .05 was chosen, but any $p < .01$ or $< .001$ will be reported. All Chi-Square analyses were run on a CDC 3600 computer using the Yale Program, Table 1.

Some of the criteria given by Lewis and Burke (9) for the use of Chi-Square as a test of independence are as follows:

1. Independence among measures
2. Adequate categorization
3. Adequate size of expected (theoretical) frequencies

With regard to criterion 1, the analyses to be stressed are between the four major illustration taxonomies (subject-matter type, physical type, objective type, and verbal modifier type) for each of which different, independent judges were used. One objective scale (Best Objective Type) was judged by the same judges as were used for the verbal modifier scales, but the judgments were separated in time and followed independent criteria.

Of the possible analyses within any of the four typologies, none will be reported which logically are not independent. For example, in the physical type scales the test of the independence of encoding medium and encoding style will not be reported because photographic media and realistic style categories required judgmental criteria that were partially overlapping.

Regarding criterion 2, all categories were established prior to the analyses except that certain categories were combined after the first computation in order to yield adequately large expected frequencies.

Regarding criterion 3, there is a difference of opinion among authorities. Quoting from another source which states that the minimum permissible expected frequency in any cell should be 10, Lewis and Burke ( ) defend 10 as the desirable minimum but allow 5 as the minimum where df and N are sufficiently large and where the X^2 is not near the lower limits of the chosen significance level. McNemar (13) is more explicit. He states that while for df=1 the discontinuity associated with low expected frequencies is marked, for df=2 or more it is less so, and for df=5 or 6 it is not serious. He then implies that under the latter circumstances expected frequencies as low as 2 are permissible. The minimum frequencies permitted in this study were as follows:

Where df ≥ 6, minimum expected frequency =2

Where df < 6, minimum expected frequency =5

For all the Chi-Square analyses having one or more cells with expected frequencies < 5, particular note is made of the fact, and particular doubt is cast on the results where X^2 is near the lower limits for a p of .05. In point of fact, however, only 11 of the 69 tables that follow have degrees of freedom of 6 or less.

Support for the above position regarding expected frequencies comes from some of the analyses done for this study. For 33 of the initial Chi-Square analyses the expected frequency in one or more cells was below 2. Certain categories were combined and the analyses rerun so as to meet the above criterion. The effect on the results was as follows:

for 25 tables, no change in level of significance

for 0 tables, a reduction in level of significance

for 8 tables, an increase in significance level including one reversed decision, non-significance to significance.

The relatively inconsequential effects may be ascribed in part to the initially high values in most cases for df and for X^2.

It would ordinarily be desirable to discuss contingency tables in two directions, rows by columns and columns by rows. However, in this report, emphasis will be given to one direction because of the view that two of the four taxonomies (subject matter and objectives) should be considered determinative of the other two, physical type and verbal modifier type.

The underlying question being asked is, given certain subject matters or certain objectives, how have the pictorial and verbal elements been, as a consequence, selected and manipulated in the design of appropriate textbook illustrations? More explicitly, what type of color, for example, was most frequently used in science illustrations, or what kind of sentence was most frequently used for analysis objectives? Statistically speaking, were physical types or verbal modifier types independent of subject-matter types or objective types?

Selected as most relevant to the above questions were the following five relationships and the corresponding 69 Chi-Square analyses:

1. Subject matter type by Objective type
2. Subject matter type by Physical type
3. Subject matter type by Verbal modifier type
4. Objective type by Physical type
5. Objective type by Verbal modifier type

The results reported in the balance of this chapter will be under the above headings and in the above order. Emphasis on these relationships reduces to manageable proportions the number of analyses to be considered. Further, as a practical expedient the contingency tables for non-significant differences are not reported, although the X^2 values are reported.

With regard to the following Chi-Square analyses, it should be noted that a significant association between two attributes of the illustrations in the sample cannot be interpreted as cause and effect. Further, a highly significant result ($p < .001$) does not necessarily indicate a high degree of association but only that an association of some magnitude is highly probable. Contingency coefficient analyses were made of the highest and lowest X^2 values to suggest the degree of association between scales.

In all the following analyses, significance relates to each table as a whole and cannot without further analysis be ascribed to particular points on the scales being compared. The largest deviations of actual frequencies from expected frequencies, whether plus or minus, provide evidence as to the most likely sources of significance. These deviations are noted in the interpretations of the tables.

Analyses of Subject Matter by Objective Type

The five Chi-Square analyses that follow test the independence of the five objective type scales from the subject-matter scale. They deal with the question: were the objectives assigned to illustrations related to the subject matter of those illustrations? All five of the associations tested were significant but varied from a p of .05 to a p of .001.

Subject matter by objective type agreement. In relation to the instructional illustrations, the frequency of occurrence of amounts of agreement on objective types was significantly associated with the subject-matter types ($p < .01$), Table 35.

TABLE 35. CHI-SQUARE FOR SUBJECT MATTER AND FOR OBJECTIVE SCALE 1: TYPE AGREEMENT

Subject Matter	Objective Type Agreement			Total
	None* 1	Partial 2	Total 3	
English	26(29.5)**	58(52.1)	11(13.4)	95
History	92(86.2)	160(152.6)	26(39.2)	278
Mathematics	56(57.0)	87(101.0)	41(26.0)	184
Science	70(71.3)	127(126.3)	33(32.4)	230
Total	244	432	111	787

$X^2 = 17.41, p < .01$

*Names and numbers of points on the scale (Table 24).

**The first number in each pair is the actual frequency; the second number, the expected frequency.

The most frequently occurring amount of agreement, Partial Agreement (two judges out of three), was the same for all subjects.

For the illustrations in each subject matter, the largest deviation from expected frequencies of objective type agreement was as follows:

English--6.2% more Partial Agreement*

Mathematics--8.2% more Total Agreement

History--4.7% less Total Agreement

Science--0.6% less No Agreement

A comparison of the patterns of deviation, Table 36, shows opposite patterns for history and mathematics, there being for history illustrations more No Agreement and Partial Agreement on objective types than expected and for mathematics illustrations more Total Agreement on objective types.

TABLE 36. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Objective Type Agreement		
	None 1	Partial 2	Total 3
English	-	+	-
History	+	+	-
Mathematics	0**	-	+
Science	-	0	0

**In all such tables the zero refers to deviations of 1.0 or less.

Subject matter by objective type pattern. In relation to the instructional illustrations, the frequency of occurrence of patterns of objective types was significantly associated with the types of subject matter ($p < .001$), Table 37.

---

*Percentages given here and in subsequent sections show the difference between the percentage expected and the percentage obtained. For example, of the English illustrations, Partial Agreement was expected on 54.9% but was actually obtained on 61.1%. Thus, there was 6.2% more Partial Agreement than expected.

TABLE 37. CHI-SQUARE FOR SUBJECT MATTER AND OBJECTIVE SCALE 2: TYPE PATTERN

Subject Matter	Objective Type Pattern						Total
	Total Agreement and Partial Agreement Among Judges					No Agreement	
	Knowledge* 1 and 6	Analysis 2 and 7	Synthesis 3 and 8	Application 4 and 9	Appreciation 5 and 10	11	
English	18(15.8)	10(15.6)	2(11.5)	14(9.3)	25(13.3)	26(29.6)	95
History	44(46.3)	64(45.6)	43(33.6)	4(27.2)	31(38.9)	92(86.5)	278
Mathematics	26(30.6)	33(30.2)	19(22.2)	41(18.0)	8(25.7)	57(57.3)	184
Science	43(38.3)	22(37.7)	31(27.8)	18(22.5)	46(32.1)	70(71.6)	230
Total	131	129	95	77	110	245	787

$$X^2 = 112.63,\ p < .001$$

*Combined points on scale (Table 25).

For the Partial and Total Agreement patterns the most frequently occurring type of objective for illustrations of each subject matter was:

English--Appreciation
History--Analysis
Mathematics--Application
Science--Knowledge and Appreciation

For illustrations in each subject the largest deviation from expected frequencies of objective types was as follows:

English--12.3% more Appreciation
History--8.4% less Application
Mathematics--12.5% more Application
Science--6.8% less Analysis

The pattern of deviations, Table 38, suggests that English and science illustrations were similar in having more Knowledge and Appreciation objectives than expected and less Analysis objectives, while

TABLE 38. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Objective Type Pattern					
	Total Agreement and Partial Agreement Among Judges					No Agreement
	Knowledge 1 and 6	Analysis 2 and 7	Synthesis 3 and 8	Application 4 and 9	Appreciation 5 and 10	11
English	+	-	-	+	+	-
History	-	+	+	-	-	+
Mathematics	-	+	-	+	-	0
Science	+	-	+	-	+	-

history and mathematics were similar in having more Analysis objectives than expected. Subjects were grouped differently for the other two objectives, i.e., English and mathematics illustrations were alike in having more Application objectives than expected, while history and science were alike in having more Synthesis objectives than expected. Note that these statements are for the 542 illustrations for which the judges were in total or partial agreement and do not include the 245 for which judges were not in agreement.

Subject matter by best objective type. In relation to the instructional illustrations, the frequency of occurrence of types of objectives was significantly associated with the subject matter of the illustrations ($p < .001$), Table 39.

The most and least frequently occurring objective types for the illustrations of each subject matter were as follows:

English--Appreciation 28.4%; Synthesis 10.5%
History--Knowledge 31.3%; Application 1.4%
Mathematics--Application 29.3%; Appreciation 8.7%
Science--Appreciation 24.8%; Application 10.9%

TABLE 39. CHI-SQUARE FOR SUBJECT MATTER AND OBJECTIVE SCALE 3: BEST OBJECTIVE TYPE

Subject Matter	Best Objective Type					Total
	Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
English	24(24.5)	23(23.4)	10(16.7)	11(11.3)	27(19.1)	95
History	87(71.7)	80(68.5)	49(48.7)	4(33.2)	58(55.8)	278
Mathematics	38(47.5)	46(45.4)	30(32.3)	54(22.0)	16(36.9)	184
Science	54(59.3)	45(56.7)	49(40.3)	25(27.5)	57(46.2)	230
Total	203	194	138	94	158	787

$X^2 = 105.03$, $p < .001$

For no subject were Analysis or Synthesis objectives most frequent. Appreciation objectives were most numerous for two subjects, while Application objectives were least numerous for two subjects. The pattern of most and least for mathematics was the inverse of that for science. See Table 26 for descriptions of points on scale.

The largest deviation from the expected frequencies of types of objectives for illustrations in each subject matter was as follows:

English--8.3% more Appreciation

History--10.5% less Application

Mathematics--17.4% more Application

Science--5.1% less Analysis

For four objective types only one subject was associated more frequently than expected (Knowledge with history, Analysis with history, Synthesis with science, and Application with mathematics), while for one objective type (Appreciation) all subjects except mathematics were associated more frequently than expected, Table 40.

TABLE 40. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Best Objective Type				
	Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
English	0	0	-	0	+
History	+	+	0	-	+
Mathematics	-	0	-	+	-
Science	-	-	+	-	+

Subject matter by objective level agreement. In relation to the instructional illustrations, the frequency of occurrence of amounts of agreement on objective levels was significantly associated with the types of subject matter ($p < .01$), Table 41. Objective level agreement refers to the amount of agreement (None, Partial, Total) among judges assigning objectives for illustrations to several difficulty levels. See Table 27 for further description of scale.

TABLE 41. CHI-SQUARE FOR SUBJECT MATTER AND OBJECTIVE SCALE 4: LEVEL AGREEMENT

Subject Matter	Objective Level Agreement			Total
	None 1	Partial 2	Total 3	
English	43(31.5)	49(53.4)	3(10.1)	95
History	86(92.2)	164(156.1)	28(29.7)	278
Mathematics	51(61.0)	101(103.3)	32(19.6)	184
Science	81(76.3)	128(129.2)	21(24.5)	230
Total	261	442	84	787

$\chi^2 = 20.77$, $p < .01$

Partial Agreement, Point 2, was the most frequent for each subject matter. The largest deviation from expected frequencies for each subject was as follows:

English--12.1% more No Agreement	Mathematics--6.7% more Total Agreement
History--2.8% more Partial Agreement	Science--2.0% more No Agreement

The pattern of deviations from expected frequencies, Table 42, is alike for English and science, there being more illustrations than expected for which there was No Agreement as to objective level and fewer for which there was Partial or Total Agreement. For history illustrations there was more Partial Agreement on objective level than expected and for mathematics illustrations there was more Total Agreement.

TABLE 42. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject	Objective Level Agreement		
	None 1	Partial 2	Total 3
English	+	-	-
History	-	+	-
Mathematics	-	-	+
Science	+	-	-

Subject matter by best objective level. The frequency of occurrence of levels of objectives for the illustrations was significantly associated with the subject matter of the illustrations ($p < .01$), Table 43.

The most frequently occurring objective level for English and mathematics was 3, Average, while that for history and science was 1 and 2, Limited. (See Table 28 for description of scale.)

TABLE 43. CHI-SQUARE FOR SUBJECT MATTER AND OBJECTIVE SCALE 5: BEST LEVEL

Subject Matter	Best Objective Level			Total
	Limited 1 and 2	Average 3	Extensive 4 and 5	
English	30(35.4)	39(38.3)	26(21.4)	95
History	117(103.5)	114(112.0)	47(62.5)	278
Mathematics	52(68.5)	73(74.1)	59(41.4)	184
Science	94(85.6)	91(92.6)	45(51.7)	230
Total	293	317	177	787

$X^2 = 20.70$, $p < .01$

The largest deviation from expected frequencies for the levels of objectives in each subject was as follows:

English--5.6% fewer Limited Level

History--5.6% fewer Extensive Level

Mathematics--9.6% more Extensive Level

Science--3.7% more Limited Level

The patterns of deviation from expected frequencies, Table 44, reveal that there were more higher level objectives for English and mathematics illustrations than expected, while there were more average or lower level objectives for history and science illustrations than expected.

TABLE 44. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Best Objective Level		
	Limited 1 and 2	Average 3	Extensive 4 and 5
English	-	0	+
History	+	+	-
Mathematics	-	-	+
Science	+	-	-

Summary. Not unexpectedly, the objectives assigned instructional illustrations varied significantly according to the subject matter for which the illustrations were intended. Regarding objective type, the largest deviation of actual from expected frequencies was for mathematics illustrations, there being 17.4% more Application objectives than expected. Regarding objective level, the largest deviation of actual from expected frequencies was also for mathematics illustrations, there being 9.6% more Extensive Level objectives than expected.

As discussed in Chapter V, the Best Type (Objective Scale 3) was defined as the "most appropriate" objective chosen, by an independent judge, from among the three objectives written by teachers for each illustration. On the other hand, the Type Pattern (Objective Scale 2) was the pattern of Total or Partial Agreement among the three teachers for 542 of the 787 illustrations. Comparison of the direction of deviations for these two scales, Tables 40 and 38, reveals little consistency; however, the largest deviation of objective type from expected frequency for each subject matter was the same for both scales, there being more Appreciation objectives than expected for English illustrations, fewer Application objectives for history, more Application objectives for mathematics, and fewer Analysis objectives for science.

The Coefficients of Contingency for the smallest and largest X^2 in this section are as follows:

C = .14 for Subject Matter by Objective Type Agreement

C = .35 for Subject Matter by Objective Type Pattern.

Analyses of Subject Matter by Physical Type

The following eleven Chi-Square analyses test the independence of the subject-matter scale from each of the eleven physical type scales. These analyses deal with the question: were the physical attributes of the illustrations related to the subject matter of the illustrations? Ten of the eleven relationships were found to be significant as shown in the tables to follow. (Refer to Chapter IV and Appendix F for descriptions of each scale.)

Subject matter by area. In relation to the instructional illustrations, the frequency of occurrence of amounts of area was significantly associated with types of subject matter ($p < .001$), Table 45. (Several points on one scale were combined to provide adequate expected frequencies.)

TABLE 45. CHI-SQUARE FOR SUBJECT MATTER AND PHYSICAL SCALE 1: AREA

Subject Matter	Area (square inches)					Total
	0-4* Point 1	5-8 Point 2	9-12 Point 3	13-17 Point 4	18+ Points 5-9	
English	5(14.4)**	8(11.5)	39(23.7)	15(12.8)	28(32.7)	95
History	11(42.0)	16(33.6)	64(69.2)	42(37.4)	145(95.7)	278
Mathematics	94(27.8)	36(22.2)	28(45.8)	13(24.8)	13(63.4)	184
Science	9(34.8)	35(27.8)	65(57.3)	36(31.0)	85(79.2)	230
Total	119	95	196	106	271	787

$X^2 = 318.37, p < .001$

*Area (square inches) and points on scale. See Table 5 for descriptions.

**The first number in each pair is the actual frequency; the second number, the expected (theoretical) frequency.

The most frequently occurring area for illustrations of each subject was as follows:

English--area 3 (medium), 41.1%	Mathematics--area 1 (small), 51.1%
History--area 5-9 (large), 52.2%	Science--area 5-9 (large), 37.0%

The largest deviation from expected frequencies was (for illustrations of each subject) as follows:

English--16.2% more area 3 (medium)*	Mathematics--36% more area 1 (small)
History--17.8% more area 5-9 (large)	Science--11.2% fewer area 1 (small)

The pattern of deviations, Table 46, was most extreme for history and mathematics, there being more small illustrations (1 and 2) associated with mathematics than expected and more large illustrations (4-9) associated with history than expected.

TABLE 46. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Area (square inches)				
	0-4 Point 1	5-8 Point 2	9-12 Point 3	13-17 Point 4	18+ Points 5-9
English	-	-	+	+	-
History	-	-	-	+	+
Mathematics	+	+	-	-	-
Science	-	+	+	+	+

Subject matter by framing. In relation to the instructional illustrations, the frequency of occurrence of framing types was significantly associated with subject matter types ($p < .001$), Table 47. (Several points on one scale were combined to provide adequate expected frequencies, although two cells remained with < 5.) (See Table 6 for descriptions of points on Framing Scale.)

---

*Percentages refer to the differences between percentage expected and percentage obtained. For example, while 24.9% area 3 were expected, 41.1% were obtained, the deviation being 16.2% more area 3 than expected.

TABLE 47. CHI-SQUARE FOR SUBJECT MATTER AND PHYSICAL SCALE 2: FRAMING

Subject Matter	Framing						Total
	Actual-Distinct Line 1	Actual-Abrupt Edge 2	Actual with Bleed 3	Implied with Bleed 4 and 6	Combination and Mixed 5 and 9	Implied 7	
English	7(5.6)	11(23.4)	3(20.0)	17(4.9)	1(4.1)	56(36.9)	95
History	13(16.2)	60(68.5)	119(58.6)	21(14.5)	16(12.0)	49(108.1)	278
Mathematics	14(10.8)	32(45.4)	10(38.8)	0(9.6)	1(7.9)	127(71.5)	184
Science	12(13.4)	91(56.7)	34(48.5)	3(12.0)	16(9.9)	74(89.4)	230
Total	46	194	166	41	34	306	787

$X^2 = 286.68$, $p < .001$

The most frequently occurring type of framing for illustrations of each subject was as follows:

English--Implied	Mathematics--Implied
History--Actual with Bleed	Science--Actual with Abrupt Edge

The largest deviation from expected frequencies of framing types (for illustrations of each subject) was as follows:

English--20.0% more Implied	Mathematics--30.1% more Implied
History--21.7% more Actual with Bleed; 21.3% less Implied	Science--14.9% more Actual with Abrupt Edge

The direction of deviations, Table 48, showed no clear pattern for either actual framing (1-3) or implied framing (4, 6, 7) types that characterized any subject. The pattern for English was similar to that for mathematics, while that for history was essentially the opposite to that for mathematics.

TABLE 48. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Framing					
	Actual-Distinct Line 1	Actual-Abrupt Edge 2	Actual with Bleed 3	Implied with Bleed 4 and 6	Combination and Mixed 5 and 9	Implied 7
English	+	-	-	+	-	+
History	-	-	+	+	+	-
Mathematics	+	-	-	-	-	+
Science	-	+	-	-	+	-

Subject matter by configuration. In relation to the instructional illustrations, the frequency of occurrence of configuration types was significantly associated with subject matter types ($p < .001$), Table 49. (Several points on one scale were combined to provide

TABLE 49. CHI-SQUARE FOR SUBJECT MATTER AND PHYSICAL SCALE 3: CONFIGURATION

Subject Matter	Configuration						Total
	Square 1	Horizontal Rectangle 2	Vertical Rectangle 3	Amoeboid, Free Form 6	Irregular, Circle, and Ellipse, Other 4,5,7	Mixed 9	
English	3(2.7)	8(25.1)	4(14.0)	73(41.6)	6(6.4)	1(5.2)	95
History	6(7.8)	115(73.5)	66(41.0)	67(121.9)	7(18.7)	17(15.2)	278
Mathematics	3(5.1)	11(48.6)	11(27.1)	127(80.7)	31(12.4)	1(10.1)	184
Science	10(6.4)	74(60.8)	35(33.9)	78(100.8)	9(15.5)	24(12.6)	230
Total	22	208	116	345	53	43	787

$X^2 = 242.76, p < .001$

adequate expected frequencies. One cell remained with an expected frequency <5, but further combination of points to eliminate it did not alter p.) (See Table 7 for descriptions of points on Configuration Scale.)

The most frequently occurring configuration was Amoeboid, Free Form, for all subject matters except history for which it was Horizontal Rectangle.

The largest deviation from expected frequencies of configuration types (for each subject matter) was as follows:

English--33.0% more Amoeboid, Free form

Mathematics--25.2% more Amoeboid, Free form

History--19.7% less Amoeboid, Free form

Science--9.9% less Amoeboid, Free form

The pattern of deviations, Table 50, was similar for English and mathematics illustrations and was essentially the opposite of that for history and science illustrations.

TABLE 50. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Configuration					
	Square 1	Horizontal Rectangle 2	Vertical Rectangle 3	Amoeboid, Free Form 6	Irregular, Circle, Ellipse, and Other 4,5,7	Mixed 9
English	0*	-	-	+	0	-
History	-	+	+	-	-	+
Mathematics	-	-	-	+	+	-
Science	+	+	+	-	-	+

---

*In all such tables the zero refers to deviations of 1.0 or less.

TABLE 51. CHI-SQUARE FOR SUBJECT MATTER AND PHYSICAL SCALE 6: POSITION

Subject Matter	Position										Total
	A,B,C 1-3	D,E,F 4-6	AD 8	AB BC 7&9	BE CF 10&11	DE EF 12&13	3-area Comb. 14-23 42	4-5 area Comb. 24-26 28-30 32-41 43	ABDE 27	BCEF 31	
English	2 (8.3)	6 (13.0)	14 (9.4)	1 (6.3)	22 (9.8)	2 (8.8)	3 (5.3)	16 (9.3)	16 (14.7)	13 (10.0)	95
History	19 (24.4)	23 (38.1)	27 (27.6)	26 (18.4)	16 (28.6)	27 (25.8)	9 (15.5)	31 (27.2)	60 (43.1)	40 (29.3)	278
Mathematics	27 (16.1)	52 (25.3)	17 (18.2)	9 (12.2)	28 (18.9)	18 (17.1)	5 (10.3)	3 (18.0)	14 (28.5)	11 (19.4)	184
Science	21 (20.2)	27 (31.6)	20 (22.8)	16 (15.2)	15 (23.7)	26 (21.3)	27 (12.9)	27 (22.5)	32 (35.7)	19 (24.3)	230
Total	69	108	78	52	81	73	44	77	122	83	787

$X^2 = 162.91, p < .001$

Subject matter by position. For the instructional illustrations, the frequency of occurrence of types of positions was significantly associated with the types of subject matter ($p < .001$), Table 51. (Many points on the one scale were combined to provide adequate expected frequencies.) (See Table 8 for descriptions of points on scale and Figure 8 for identification of positions A, B, C, etc.)

The most frequently occurring position (before points were combined) for illustrations of each subject was as follows:

English--CF (bottom 1/3 of page)	Mathematics--D (upper right 1/6 of page)
History--ABDE (top 2/3)	Science--ABDE (top 2/3)

The largest deviation from expected frequencies of positions (after points were combined) for illustrations of each subject matter was as follows:

English--12.9% more BE, CF	Mathematics--14.6% more D,E,F
History--6.1% more ABDE	Science--6.1% more 3-area combinations

The pattern of deviations, Table 52, suggests that for mathematics illustrations there were more single area positions than expected

TABLE 52. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Position									
	A,B, C 1-3	D,E, F 4-6	AD 8	AB BC 7&9	BE CF 10& 11	DE EF 12& 13	3-area Comb. 14-23 42	4-5 area Comb. 24-26 28-30 32-41 43	ABDE 27	BCEF 31
English	-	-	+	-	+	-	-	+	+	+
History	-	-	0	+	-	+	-	+	+	+
Mathematics	+	+	-	-	+	+	-	-	-	-
Science	0	-	-	0	-	+	+	+	-	-

(A,B,C,D,E,F,) while for English and history illustrations there were more 4 and 5 area positions than expected. More English illustrations were horizontally positioned across the top (AD), middle (BE), and bottom (CF) than expected, while more history and science illustrations were positioned vertically to the left (AB,BC) or to the right (DE,EF) than expected.

For all subjects combined, there were more single-area illustrations positioned on the right half of the pages (D,E,F) than on the left half (A,B,C). This predominance of right-half positions over left-half holds for 2-area and 3-area positions as well. Table 51 does not show this because of the combined categories, but it is shown earlier in this chapter, Table 34.

For all subjects combined, there were more illustrations positioned in the upper third of the page than in the lower third and more in the lower third than in the middle third. This holds for single area and 2-area positions. Similarly, there were more illustrations in ABDE, upper 2/3, than in BCEF, lower 2/3.

Subject matter by elements. The frequency of occurrence of types of elements (pictorial, verbal, design) in the illustrations was significantly associated with the types of subject matter of the illustrations ($p < .001$), Table 53. (One cell had expected frequencies < 5.) (See Table 9 for descriptions of points on Elements Scale.)

The most frequently occurring type of element(s) for each subject was:

English--Pictorial and Verbal, 48.4%
History--Pictorial, 58.3%
Mathematics--Pictorial and Verbal, 53.8%
Science--Pictorial, 45.7%

TABLE 53. CHI-SQUARE FOR SUBJECT MATTER AND PHYSICAL SCALE 5: ELEMENTS

Subject Matter	Elements				Total
	Pictorial Only 1	Pictorial and Verbal 2	Pictorial and Design 3	Pictorial, Verbal, and Design 4	
English	31(38.1)	46(29.6)	18(24.5)	0(2.8)	95
History	162(111.6)	51(86.5)	58(71.7)	7(8.1)	278
Mathematics	18(73.9)	99(57.3)	66(47.5)	1(5.4)	184
Science	105(92.4)	49(71.6)	61(59.3)	15(6.7)	230
Total	316	245	203	23	787

$X^2 = 157.63$, $p < .001$

The largest deviation from expected frequencies of types of elements (for illustrations of each subject) was as follows:

English--17.3% more Pictorial and Verbal

History--18.1% more Pictorial only

Mathematics--30.4% less Pictorial only

Science--9.8% less Pictorial and Verbal

As shown in Table 54 for the three most numerous types (1-3), the pattern of deviations from expected frequencies was unique for each

TABLE 54. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Elements			
	Pictorial Only 1	Pictorial and Verbal 2	Pictorial and Design 3	Pictorial, Verbal and Design 4
English	-	+	-	-
History	+	-	-	-
Mathematics	-	+	+	-
Science	+	-	+	+

subject, English being the inverse of science, and history being essentially the inverse of mathematics.

In sum, types of elements were disproportionately distributed across subject matter, there being for English more illustrations than expected with a combination of pictorial and verbal elements, for history more than expected with pictorial elements only, for mathematics more than expected with combinations of pictorial and verbal or pictorial and design, and for science more than expected with pictorial elements only and with all combinations except pictorial and verbal.

Subject matter by chroma. The frequency of occurrence of chromatic types of illustrations was significantly associated with subject matter of the illustrations ($p < .001$), Table 55. (Several points on one of the scales were combined to provide adequate expected frequencies, although two cells had <5.) (See Table 10 for descriptions of points on Chromatic Scale.)

TABLE 55. CHI-SQUARE FOR SUBJECT MATTER AND PHYSICAL SCALE 6: CHROMA

Subject Matter	Chromatic					Total
	Non- 1	Mono- and Duo- 2,3	Tri- and Poly- 4,5	Full- 6	Mixed 9	
English	15(37.1)	61(44.5)	17(7.0)	2(3.7)	0(2.7)	95
History	153(108.4)	89(130.3)	15(20.5)	14(11.0)	7(7.8)	278
Mathematics	56(71.8)	117(86.3)	10(13.6)	0(7.2)	1(5.1)	184
Science	83(89.7)	102(107.8)	16(17.0)	15(9.1)	14(6.4)	230
Total	307	369	58	31	22	787

$X^2 = 110.38$, $p < .001$

For history, the most frequently occurring type was Non-chromatic, while for all other subjects the most frequent was Mono-chromatic. There were no Full-chromatic illustrations in the mathematics sample and only two in English.

The largest deviation from expected frequencies of chromatic types (for illustrations of each subject) was as follows:

English--23.2% fewer Non-chromatic

History--16.0% more Non-chromatic

Mathematics--16.7% more Mono- and Duo-chromatic

Science--3.3% more Mixed chromatic

As shown in Table 56, more Full-chromatic illustrations than expected were in science and history and more Mono-chromatic than expected were in English and mathematics. Only English had more Tri- and Poly-chromatic than expected, and only science had more Mixed-chromatic than expected.

TABLE 56. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Chromatic				
	Non- 1	Mono- and Duo- 2,3	Tri- and Poly- 4,5	Full- 6	Mixed 9
English	-	+	+	-	-
History	+	-	-	+	0
Mathematics	-	+	-	-	-
Science	-	-	0	+	+

Subject matter by achroma. The frequency of occurrence of achromatic types (black to white) of illustrations was significantly associated with the subject matter of the illustrations ($p < .001$), Table 57. (Two points on one scale were combined to provide adequate expected frequencies, although one cell still had <5.) (See Table 11 for descriptions of the points on Achromatic Scale.)

TABLE 57. CHI-SQUARE FOR SUBJECT MATTER AND PHYSICAL SCALE 7: ACHROMA

Subject Matter	Achromatic						Total
	Non- 1	Mono- 2	Duo- 3	Tri- and Poly- 4,5	Full- 6	Mixed 9	
English	5(9.1)	44(37.5)	18(10.9)	22(17.1)	6(17.3)	0(3.1)	95
History	28(26.5)	66(109.9)	29(31.8)	80(50.2)	64(50.5)	11(9.2)	278
Mathematics	21(17.5)	125(72.7)	31(21.0)	6(33.2)	1(33.4)	0(6.1)	184
Science	21(21.9)	76(90.9)	12(26.3)	34(41.5)	72(41.8)	15(7.6)	230
Total	75	311	90	142	143	26	787

$X^2 = 202.50$, $p < .001$

The most frequently occurring achromatic type of illustration for each subject was:

English--Mono-achromatic, 46.3%	Mathematics--Mono-achromatic, 67.9%
History--Tri- and Poly-achromatic, 28.8%	Science--Mono-achromatic, 33.0%

The largest deviation of actual from expected frequencies of achromatic types (for illustrations of each subject) was as follows:

English--11.9% fewer Full-achromatic	Mathematics--28.4% more Mono-achromatic
History--15.8% fewer Mono-achromatic	Science--13.1% more Full-achromatic

In Table 58 can be seen that each subject area has its unique pattern of deviations from expected frequencies, but there is similarity between English and mathematics and between history and science except for Points 1 and 4,5. English and mathematics had more than the expected number of Mono- and Duo-achromatic illustrations, while history and science had more than the expected number of Full- and Mixed-achromatic illustrations.

TABLE 58. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Achromatic					
	Non- 1	Mono- 2	Duo- 3	Tri- and Poly- 4,5	Full- 6	Mixed- 9
English	-	+	+	+	-	-
History	+	-	-	+	+	+
Mathematics	+	+	+	-	-	-
Science	0	-	-	-	+	+

Subject matter by encoding medium. In relation to the instructional illustrations, the frequency of occurrence of encoding media types was significantly associated with subject matter types ($p < .001$), Table 59. (One cell had an expected frequency < 5.) (See Table 12 for

TABLE 59. CHI-SQUARE FOR SUBJECT MATTER AND PHYSICAL SCALE 8: ENCODING MEDIUM

Subject Matter	Encoding Medium				Total
	Photographic 1	Artistic Two-Dimensional 2	Mechanical 3	Mixed 9	
English	4(21.4)	78(43.5)	9(26.0)	4(4.2)	95
History	79(62.5)	148(127.2)	33(75.9)	18(12.4)	278
Mathematics	0(41.4)	27(84.2)	154(50.3)	3(8.2)	184
Science	94(51.7)	107(105.2)	19(62.8)	10(10.2)	230
Total	177	360	215	35	787

$X^2 = 449.99$, $p < .001$

descriptions of points on Encoding Medium Scale.)

The most frequent type of encoding medium for illustrations of each subject matter was as follows:

English--Artistic, 82.1%	Mathematics--Mechanical, 83.7%
History--Artistic, 53.2%	Science--Artistic, 46.5%

The largest deviation of actual from expected frequencies for illustrations of each subject was as follows:

English--36.4% more Artistic	Mathematics--56.4% more Mechanical
History--15.4% less Mechanical	Science--19.0% less Mechanical and 18.4% more Photographic

The pattern of deviations from expected frequencies, Table 60, was essentially the same for history and science illustrations. No mathematics illustrations in the sample were photographic.

TABLE 60. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Encoding Medium			
	Photographic 1	Artistic Two-Dimensional 2	Mechanical 3	Mixed 9
English	-	+	-	0
History	+	+	-	+
Mathematics	-	-	+	-
Science	+	+	-	0

Subject matter by encoding style. In relation to the instructional illustrations, the frequency of occurrence of encoding styles was significantly associated with subject matter types ($p < .001$), Table 61. (Several points on one scale were combined to provide adequate expected frequencies, although two cells still had <5.) (See Table 13 for descriptions of points on Encoding Style Scale.)

TABLE 61. CHI-SQUARE FOR SUBJECT MATTER AND PHYSICAL SCALE 9: ENCODING STYLE

Subject Matter	Encoding Style				Total
	Realistic 1	Cartoon 2	Diagrammatic 3	Other 4,5,9	
English	60(52.3)	28(4.7)	1(33.8)	6(4.2)	95
History	207(153.0)	8(13.8)	49(98.9)	14(12.4)	278
Mathematics	19(101.2)	0(9.1)	162(65.5)	3(8.2)	184
Science	147(126.5)	3(11.4)	68(81.8)	12(10.2)	230
Total	433	39	280	35	787

$X^2 = 429.57$, $p < .001$

The most frequently occurring encoding style for each subject matter was as follows:

English--Realistic, 63.2%

History--Realistic, 74.5%

Mathematics--Diagrammatic, 88.0%

Science--Realistic, 63.9%

There were no Cartoon style illustrations for mathematics and only one Diagrammatic style illustration for English.

The largest deviation of actual from expected frequencies of encoding styles (for illustrations of each subject) was as follows:

English--34.5% fewer Diagrammatic

History--19.5% more Realistic

Mathematics--44.7% fewer Realistic and 52.4% more Diagrammatic

Science--8.9% more Realistic

The pattern of deviations, Table 62, from expected frequencies was the same for history and science. The pattern for English was the opposite of that for mathematics. Realistic style illustrations were more numerous than expected for all subjects except mathematics. English was the only subject having more Cartoon illustrations than expected, and mathematics was the only subject having more Diagrammatic illustrations than expected.

TABLE 62. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Encoding Style			
	Realistic 1	Cartoon 2	Diagrammatic 3	Other 4,5,9
English	+	+	-	+
History	+	-	-	+
Mathematics	-	-	+	-
Science	+	-	-	+

Subject matter by information level. In relation to the instructional illustrations, the frequency of occurrence of information levels was significantly associated with subject matter types ($p < .001$), Table 63. (Two points on one scale were combined to provide adequate expected frequencies, although one cell still had <5.) ("High" and "Low" Information Levels in Table 63 are oversimplified terms for various degrees and combinations of Environment, Shading, Dimensionality, and Interior Detail as specified earlier in Table 14.)

The information level most frequently associated with illustrations of each subject was as follows:

English--point 1, 42.1%	Mathematics--point 4,5, 87.5%
History--point 1, 63.7%	Science--point 1, 44.3%

The largest deviation of actual from expected frequencies of information levels (for illustration of each subject) was as follows:

TABLE 63. CHI-SQUARE FOR SUBJECT MATTER AND PHYSICAL SCALE 10: INFORMATION

Subject Matter	Information Level					Total
	High 1	2	3	Low 4,5	Mixed 9	
English	40(39.5)	5(4.7)	31(12.8)	14(32.6)	5(5.4)	95
History	177(115.5)	1(13.8)	33(37.4)	48(95.4)	19(15.9)	278
Mathematics	8(76.5)	3(9.1)	10(24.8)	161(63.1)	2(10.5)	184
Science	102(95.6)	30(11.4)	32(31.0)	47(78.9)	19(13.2)	230
Total	327	39	106	270	45	787

$X^2 = 385.00$, $p < .001$

English--19.1% more point 3, Medium, and 19.6% less point 4,5, Low

History--22.2% more point 1, High

Mathematics--37.3% fewer point 1, High, and 53.2% more point 4,5, Low

Science--13.9% fewer points 4,5, Low

The pattern of deviations of actual from expected frequencies, Table 64, for science was in contrast to that for mathematics. History had a greater number than expected of High information level illustrations (point 1) while mathematics had a greater number of Low information level illustrations (point 4,5).

TABLE 64. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Information Level				
	High 1	2	3	Low 4,5	Mixed 9
English	0	0	+	-	0
History	+	-	-	-	+
Mathematics	-	-	-	+	-
Science	+	+	0	-	+

Subject matter by unification. With reference to the textbook illustrations, the frequency of occurrence of degrees of unification was non-significantly related to types of subject matter. The Chi-Square was 9.71 at 6 df.

Summary. Ten of the eleven physical type scales were significantly related to subject matter, and the associated significance levels were high ($p < .001$). In eight of the ten cases the largest percentage of deviation from expected frequencies was for mathematics illustrations. In seven of the ten cases the lowest maximum percentage of deviation from the expected frequencies for a subject was for science illustrations.

It was of interest to note whether there was any tendency for the deviations of actual from expected frequencies of physical types to form patterns, i.e., for the deviations for one subject matter to tend to be alike or unlike those for other subject matter. The most frequently occurring pattern (36% of the cases) was one in which English and mathematics deviations were in the same direction while history and science deviations were in the opposite direction. The next most frequently occurring pattern (21% of the cases) was one in which mathematics deviations were in one direction, while the other three were in the opposite direction. Thus, two of the seven possible patterns accounted for over half of the cases.

The Coefficients of Contingency for the smallest and largest X^2 in this section are as follows:

$C = .35$ for Subject Matter by Chroma

$C = .60$ for Subject Matter by Encoding Medium.

It would be possible from these data to describe the most frequent or most probable physical characteristics of an illustration for each subject matter. For example, the "typical" American history illustration would: be a large size (18+ sq. in.); have an Actual frame with bleed; be a Horizontal rectangle; be in the upper 2/3 of the page; have pictorial elements only; have no color; be Tri- or Poly-achromatic; be in an Artistic medium; be Realistic in style; be in a natural environment and have full shading, full dimensionality and full interior detail; and be fully unified.

Table 65 gives comparable information about the most frequently occurring point on each physical scale for each of the other subject matters. For example, for Physical Scale 5: Elements, point #1 (pictorial only) was the most frequent or most probable for history illustrations. One could say that 58% of history illustrations had pictorial elements only (within the pictorial unit), or that .58 was the best estimate of the probability that a history illustration would have pictorial elements only.

The data in Table 65 do not necessarily indicate the sources of the statistically significant differences found. Note also that, while the point number for each physical scale is given, the name or description of it may be so abbreviated as to lead to erroneous interpretations. See Chapter IV and Appendix F for more complete descriptions.

In sum, the ten analyses reveal systematic differences in the physical types of illustrations as a function of the subject matter of the illustrations. In a way these data constitute "hypotheses" stating that the learning of each subject can be optimized by illustrations having certain physical attributes. These "hypotheses" may serve to suggest directions for future research.

TABLE 65. MOST FREQUENTLY OCCURRING POINT ON PHYSICAL TYPE SCALES FOR ILLUSTRATIONS OF EACH SUBJECT MATTER AND PERCENTAGE OF ILLUSTRATIONS OF EACH SUBJECT MATTER THAT WERE AT THAT POINT

Physical Type Scales	Subject Matter							
	English		History		Mathematics		Science	
	Point	Per cent	Point	Per cent	Point	Per cent	Point	Per cent
1. Area	3, Medium	41	5-9, Large	52	1, Small	51	5-9, Large	37
2. Framing	7, Implied	59	3, Actual, with bleed	43	7, Implied	69	2, Actual, abrupt edge	40
3. Configuration	6, Amoeboid, Free-form	77	2, Horizontal rectangle	41	6, Amoeboid, Free-form	69	6, Amoeboid, Free-form	34
4. Position	11, Bottom 1/3	21	27, Upper 2/3	22	4, Upper right 1/6	11	27, Upper 2/3	14
5. Elements	2, Pictorial and Verbal	48	1, Pictorial only	58	2, Pictorial and Verbal	54	1, Pictorial only	46
6. Chroma	2-3, Mono- and Duo-chromatic	64	1, Non-chromatic	55	2-3, Mono- and Duo-chromatic	64	2-3, Mono- and Duo-chromatic	44
7. Achroma	2, Mono-achromatic	46	4-5, Tri- and Poly-achromatic	29	2, Mono-achromatic	68	2, Mono-achromatic	33
8. Medium	2, Artistic	82	2, Artistic	53	3, Mechanical	84	2, Artistic	47
9. Style	1, Realistic	63	1, Realistic	75	3, Diagrammatic	88	1, Realistic	64
10. Information	1, High level	42	1, High level	64	4-5, Low level	88	1, High level	44

Analyses of Subject Matter by Verbal Modifier Type

The five Chi-Square analyses that follow test the independence of the five verbal modifier type scales from the subject matter scale. They deal with the question: were the verbal modifiers of the illustrations related to the subject matter of the illustrations? All five relationships were found to be significant, as shown in the analyses to follow.

Subject matter by verbal modifier-type. The frequency of occurrence of types of verbal modifiers for illustrations was significantly associated with types of subject matter ($p < .001$), Table 66.

TABLE 66. CHI-SQUARE FOR SUBJECT MATTER AND VERBAL MODIFIER SCALE 1: TYPE

Subject Matter	Verbal Modifier Types				Total
	None* 1	Sentences 2	Non-sentences 3	Both 4	
English	17(5.2)**	14(18.5)	26(21.4)	38(50.0)	95
History	7(15.2)	86(54.0)	52(62.5)	133(146.2)	278
Mathematics	8(10.1)	9(35.8)	42(41.4)	125(96.8)	184
Science	11(12.6)	44(44.7)	57(51.7)	118(121.0)	230
Total	43	153	177	414	787

$X^2 = 87.60, p < .001$

The most frequent type of verbal modifier for all subject matters was 4, Both Sentence and Non-sentence.

---

*Names and numbers of points on the scale (Table 29).

**The first number in each pair is actual frequency; the second number, the expected (theoretical) frequency.

The largest deviation from expected frequency for each subject was as follows:

English--12.6% less Both (sentences and non-sentences); 12.4% more None*	Mathematics--15.3% more Both; 14.5% fewer Sentences
History--11.5% more Sentences	Science--2.3% more Non-sentences

There appeared to be no consistent patterns of deviation, Table 67, for verbal modifier types in relation to subject matter. It may be of interest that English was the only subject for which there were more illustrations than expected with no verbal modifiers. History illustrations had more Sentences than expected; mathematics illustrations had more Both Sentences and Non-sentences, and science illustrations had more Non-sentences.

TABLE 67. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Verbal Modifier Type			
	None 1	Sentences 2	Non-sentences 3	Both 4
English	+	-	+	-
History	-	+	-	-
Mathematics	-	-	0	+
Science	-	0**	+	-

---

*Percentages refer to the difference between the percentage expected and the percentage obtained. For example, while 52.6% Both were expected, 40% were obtained, the deviation being 12.6% less Both than expected.

**In all such tables the zero refers to deviations of 1.0 or less.

Subject matter by sentence pattern. The frequency of occurrence of patterns of sentences modifying the illustrations was significantly associated with the subject matter of the illustrations ($p < .001$), Table 68. (Several points on one scale were combined to provide adequate expected frequencies. Two cells remained with expected frequencies < 5. Further combination of points to eliminate these did not alter p.) (See Table 31 for descriptions of points on Sentence Pattern Scale.)

TABLE 68. CHI-SQUARE FOR SUBJECT MATTER AND VERBAL MODIFIER SCALE 3: SENTENCE PATTERNS

Subject Matter	Sentence Patterns							Total
	None 1	Declarative 2	Interrogative, Imperative or Other 3,4,5	Declarative and Interrogative 6	Declarative and Imperative 7	All Other Paired Types 8-11	Three or More Types 12-16	
English	43 (26.3)	18 (36.5)	7 (4.9)	3 (8.8)	8 (6.2)	5 (3.1)	11 (9.2)	95
History	57 (77.0)	169 (106.7)	8 (14.5)	22 (25.8)	13 (18.0)	6 (9.2)	3 (26.8)	278
Mathematics	50 (51.0)	14 (70.6)	22 (9.6)	21 (17.1)	25 (11.9)	8 (6.1)	44 (17.8)	184
Science	68 (63.7)	101 (88.3)	4 (12.0)	27 (21.3)	5 (14.9)	7 (7.6)	18 (22.2)	230
Total	218	302	41	73	51	26	76	787

$X^2 = 227.80$, $p < .001$

The most frequently occurring sentence pattern in relation to each subject matter was as follows:

English--No sentence (45.3%)

History--Declarative (60.8%)

Mathematics--No sentence (27.2%)

Science--Declarative (43.9%)

The largest deviation from expected frequencies of sentence patterns (for each subject matter) was as follows:

English--19.5% fewer Declarative

History--22.4% more Declarative

Mathematics--30.8% fewer Declarative

Science--5.5% more Declarative

As shown in Table 69, more declarative sentences (2) and fewer other single types of sentences (3-5) than expected were associated with history and science illustrations, while the opposite was the case for English and mathematics illustrations, more other sentence types and fewer declarative than expected. Combinations of types of sentences (6-16) were generally more frequent for English and mathematics illustrations than for history and science illustrations.

TABLE 69. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Sentence Patterns						
	None 1	Declarative 2	Interrogative, Imperative or Other 3,4,5	Declarative and Interrogative 6	Declarative and Imperative 7	All Other Paired Types 8-11	Three or More Types 12-16
English	+	-	+	-	+	+	+
History	-	+	-	-	-	-	-
Mathematics	0	-	+	+	+	+	+
Science	+	+	-	+	-	0	-

In sum, the sentences modifying illustrations were predominantly of one type (declarative) for history and science but were comparatively diversified in type for English and mathematics.

Subject matter by non-sentence pattern. The frequency of occurrence of the patterns of non-sentence verbal modifiers was significantly associated with the subject matter of the illustrations ($p < .001$), Table 70. (One cell had an expected frequency <5. Several points on one scale were combined to provide adequate expected frequencies.) (See Table 33 for descriptions of points on Non-sentence Pattern Scale.)

TABLE 70. CHI-SQUARE FOR SUBJECT MATTER AND VERBAL MODIFIER SCALE 5: NON-SENTENCE PATTERNS

Subject Matter	Non-sentence Patterns					Total
	None 1	Titles 2	Labels 3	Titles and Labels 4,5	Legends with Titles, Labels 6-8	
English	31(23.7)	16(15.8)	28(26.6)	20(25.1)	0(3.9)	95
History	93(69.2)	63(46.3)	34(77.7)	61(73.5)	27(11.3)	278
Mathematics	17(45.8)	11(30.6)	82(51.4)	74(48.6)	0(7.5)	184
Science	55(57.3)	41(38.3)	76(64.3)	53(60.8)	5(9.4)	230
Total	196	131	220	208	32	787

$X^2 = 144.98$, $p < .001$

The type of non-sentence most frequently associated with each subject was as follows:

English--No non-sentence	Mathematics--Labels
History--No non-sentence	Science--Labels

Eighty-seven per cent of illustrations with Legends were in history, and there were none in English or mathematics.

The largest deviations from expected frequencies of non-sentence modifiers (for each subject) were as follows:

English--7.7% more None (illustrations without non-sentence modifiers)	Mathematics--16.6% more Labels; 15.7% less None
History--15.8% less Labels	Science--5% more Labels

As can be seen in Table 71, with each subject was associated a particular pattern of greater or less than expected frequencies of non-sentence modifiers of illustrations. Of the illustrations with non-sentence modifiers, English illustrations had more Labels than expected; history illustrations had both more Titles and more Legends; mathematics illustrations had both more Labels and more combined Titles and Labels; and science illustrations had both more Titles and more Labels.

TABLE 71. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Non-sentence Patterns				
	None 1	Titles 2	Labels 3	Titles and Labels 4,5	Legends with Titles, Labels 6-8
English	+	0	+	-	-
History	+	+	-	-	+
Mathematics	-	-	+	+	-
Science	-	+	+	-	-

Subject matter by sentence quantity. The frequency of occurrence of sentence modifiers of illustrations was significantly associated with the subject matter of the illustrations ($p < .001$), Table 72. (One cell had an expected frequency <5. Several points on one scale were combined to provide adequate expected frequencies.) (See Table 30 for descriptions of points on the Sentence Quantity Scale.)

TABLE 72. CHI-SQUARE FOR SUBJECT MATTER AND VERBAL MODIFIER SCALE 2: SENTENCE QUANTITY

Subject Matter	Sentence Quantity								Total
	None 1	One 2	Two 3	Three 4	Four 5	5-6 6	7-10 7	11+ 8-10	
English	43 (26.3)	11 (17.3)	14 (17.7)	6 (9.5)	1 (5.9)	7 (6.6)	4 (4.2)	9 (7.4)	95
History	58 (77.0)	78 (50.5)	72 (51.9)	26 (27.9)	17 (17.3)	12 (19.4)	7 (12.4)	8 (21.5)	278
Mathematics	50 (51.0)	19 (33.4)	22 (34.4)	16 (18.5)	20 (11.5)	15 (12.9)	15 (8.2)	27 (14.3)	184
Science	67 (63.7)	35 (41.8)	39 (43.0)	31 (23.1)	11 (14.3)	21 (16.1)	9 (10.2)	17 (17.8)	230
Total	218	143	147	79	49	55	35	61	787

$X^2 = 102.29$, $p < .001$

For English, 45.3% of illustrations had no sentence modifiers. Disregarding type 1, None, the most frequent number of sentences occurring with illustrations for each subject was as follows:

English--Two
History--One
Mathematics--Eleven+
Science--Two

Disregarding type 1, the largest departure from expected frequencies of sentences modifying illustrations was as follows:

English--17.6% more None (illustrations with no sentence modifier)

History--9.9% more One (illustrations with one modifying sentence)

Mathematics--7.9% fewer One; 6.9% more Eleven+

Science--3.5% more Three

As suggested in Table 73, fewer than expected of most sentence quantities were associated with English pictures. English deviated from expectations both by having more illustrations with no sentences and by having more with eleven plus sentences. While there were more history illustrations with one or two sentences than expected, there were more mathematics illustrations with four to eleven plus sentences than expected.

TABLE 73. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Sentence Quantity							
	None	One	Two	Three	Four	5-6	7-10	11+
	1	2	3	4	5	6	7	8-10
English	+	-	-	-	-	0	0	+
History	-	+	+	-	0	-	-	-
Mathematics	0	-	-	-	+	+	+	+
Science	+	-	-	+	-	+	-	0

Subject matter by non-sentence quantity. The frequency of occurrence of non-sentence modifiers of illustrations was significantly associated with the subject matter of the illustrations ($p < .001$), Table 74. (Two cells had an expected frequency of <5.) (See Table 32 for descriptions of points on Non-sentence Quantity Scale.)

About one third of English and history illustrations had no non-sentence modifiers. Disregarding type 1 (None), the most frequently occurring quantity of non-sentence modifiers for illustrations of each subject was as follows:

English--One (20.0%)	Mathematics--9-12(16.3%)
History--One (26.3%)	Science--One (16.1%)

The largest deviation from the expected frequencies of non-sentence modifiers of illustrations (for each subject) was as follows:

TABLE 74. CHI-SQUARE FOR SUBJECT MATTER AND VERBAL MODIFIER SCALE 4: NON-SENTENCE QUANTITY

Subject Matter	Non-sentence Quantity										Total
	None 1	One 2	Two 3	Three, Four 4	Five, Six 5	Seven, Eight 6	9-12 7	13-21 8	22-41 9	42+ 10	
English	31 (23.7)	19 (16.9)	18 (10.3)	11 (9.8)	8 (7.2)	1 (6.2)	3 (6.8)	2 (6.3)	1 (4.1)	1 (3.9)	95
History	93 (69.2)	73 (49.5)	24 (30.0)	17 (28.6)	8 (21.2)	5 (18.0)	8 (19.8)	14 (18.4)	19 (12.0)	17 (11.3)	278
Mathematics	17 (45.8)	11 (32.7)	9 (19.9)	27 (18.9)	27 (14.0)	28 (11.9)	30 (13.1)	23 (12.2)	8 (7.9)	4 (7.5)	184
Science	55 (57.3)	37 (40.9)	34 (24.8)	26 (23.7)	17 (17.5)	17 (14.9)	15 (16.4)	13 (15.2)	6 (9.9)	10 (9.4)	230
Total	196	140	85	81	60	51	56	52	34	32	787

$X^2 = 195.45, p < .001$

TABLE 75. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Subject Matter	Non-sentence Quantity									
	None 1	One 2	Two 3	Three, Four 4	Five, Six 5	Seven, Eight 6	9-12 7	13-21 8	22-41 9	42+ 10
English	+	+	+	+	0	-	-	-	-	-
History	+	+	-	-	-	-	-	-	+	+
Mathematics	-	-	-	+	+	+	+	+	0	-
Science	-	-	+	+	0	+	-	-	-	0

English--8.1% more Two (illustrations with two non-sentence modifiers); 7.7% more None

History--8.6% more None (illustrations with no non-sentence modifiers); 8.5% more One

Mathematics--15.7% fewer None

Science--4.0% more Two

As shown in Table 75, English illustrations had a greater than expected frequency of non-verbal modifiers in the 1-4 range while mathematics illustrations had more in the 3 to 21 range. History illustrations had more than the expected number of non-sentence modifiers in both the lowest and highest quantities, the latter probably being due to the very large number of labels on some history maps.

Summary. All five of the scales for the verbal modifiers of illustrations were significantly associated with the subject matter of the illustrations, and all the significance levels were high ($p < .001$). The maximum percentage of deviation from expected frequencies for each subject was highest for mathematics illustrations on four of five scales and lowest for science illustrations on all scales.

The two most frequently occurring patterns of deviation (24% each) were as follows: one, where English and mathematics deviations were in the same direction, while history and science deviations were in the opposite direction; and two, where history deviations were in one direction and the other three in the opposite direction. The next most frequently occurring pattern (21%) was one in which mathematics deviations were in one direction and the other three in the opposite direction. Thus, three of the seven possible patterns accounted for 69% of the cases.

The Coefficients of Contingency for the smallest and largest X^2 in this section are as follows:

C = .32 for Subject Matter by Verbal Modifier Type

C = .47 for Subject Matter by Sentence Pattern.

The illustrations for each subject matter could be characterized as to their most frequently occurring or most probable verbal modifiers. For example, English illustrations typically had both Sentence and Non-sentence modifiers, if with sentences they were Declarative, if with non-sentences they were Labels, if with sentences there were two, and if with non-sentences there was one.

Table 76 gives comparable information about the most frequently occurring point on each verbal modifier scale for each of the other subject matters. For example, for Verbal Modifier Scale 3: Sentence Pattern, Point #2 (Declarative) was the most frequent or probable for science illustrations. One could say that 44% of science illustrations had one or more declarative sentences as verbal modifiers or that .44 was the best estimate of the probability that a particular science illustration would have an associated declarative sentence.

The data in Table 76 do not necessarily indicate the sources of the statistically significant differences found. Note also that while the point number for each verbal modifier scale is given, the name or description of it may be so abbreviated as to lead to erroneous interpretation. See Chapter VI for more complete descriptions.

In sum, the five analyses reveal systematic differences in the verbal modifiers of illustrations as a function of the subject matter of those illustrations. In a way these data constitute "hypotheses"

TABLE 76. MOST FREQUENTLY OCCURRING POINT ON VERBAL MODIFIER SCALES FOR ILLUSTRATIONS OF EACH SUBJECT MATTER AND PERCENTAGE OF ILLUSTRATIONS OF EACH SUBJECT THAT WERE AT THAT POINT

Verbal Modifier Scales	Subject Matter							
	English		History		Mathematics		Science	
	Point	Per cent	Point	Per cent	Point	Per cent	Point	Per cent
1. Type	4, Both sentences and non-sentences	40	4, Both sentences and non-sentences	48	4, Both sentences and non-sentences	68	4, Both sentences and non-sentences	51
2. Sentence Quantity	3, Two	15	2, One	28	8-10, Eleven+	15	3, Two	17
3. Sentence Pattern	2, Declarative	19	2, Declarative	61	12-16, Three or or more types	24	2, Declarative	44
4. Non-sentence Quantity	2, One	20	2, One	26	7, Nine to twelve	16	2, One	16
5. Non-sentence Pattern	3, Label	30	2, Title	23	3, Label	45	3, Label	33

stating that the learning of each subject matter can be optimized by illustrations having verbal modifiers of certain types. These "hypotheses" may serve to suggest directions for future research.

Analyses of Objective Types by Physical Types

The 55 Chi-Square analyses that follow test the independence of the 11 physical type scales from the five objective type scales. These analyses deal with the question: were the physical attributes of the illustrations related to the educational objectives assigned to those illustrations? In approximately 60% of the cases the relationships were found to be statistically significant.

This section has been divided into five parts, each containing 11 analyses. For each part, one objective scale has been presented in relation to each of the 11 physical type scales.

Part I

The first objective type scale, Type Agreement, measured the degree of agreement among the three judges as to the most appropriate type of objective for each illustration. Only two of the 11 physical scales were significantly associated with this scale, as shown in the analyses to follow.

Objective type agreement by area. With reference to the instructional illustrations, the frequency of occurrence of amounts of area was significantly associated with the amount of agreement on objective types ($p < .02$), Table 77. (Several points on one scale were combined to provide adequate expected frequencies.)

TABLE 77. CHI-SQUARE FOR OBJECTIVE SCALE 1: TYPE AGREEMENT AND PHYSICAL SCALE 1: AREA

Area (square inches)	Point on Scale*	Objective Type Agreement			Total
		None 1*	Partial 2	Total 3	
0-4	1	33(36.9)**	55(65.3)	31(16.8)	119
5-8	2	26(29.5)	56(52.1)	13(13.4)	95
9-12	3	65(60.8)	108(107.6)	23(27.6)	196
13-17	4	39(32.9)	57(58.2)	10(15.0)	106
18+	5-9	81(84.0)	156(148.8)	34(38.2)	271
Total		244	432	111	787

$X^2 = 19.59$, $p < .02$

The most frequently occurring size of illustrations was the same, 18+ square inches, for all levels of agreement on objective type.

The largest deviation from expected frequencies of sizes of illustrations at each level of agreement regarding objective type was as follows:

No agreement--2.5% more area 4 (13-17 square inches)***
Partial agreement--2.4% fewer area 1 (0-4 square inches)
Total agreement--12.8% more area 1 (0-4 square inches)

The pattern of deviations, Table 78, suggests that more medium area illustrations (9-17 square inches) than expected were associated with No Agreement on the type of objective, while more small illustrations (0-4 square inches) than expected were associated with Total Agreement on objective type.

---

*Names and numbers of points on the scale. (See Table 5 for description of points on Area Scale and Table 24 for points on Objective Type Agreement Scale.)

**The first number in each pair is the actual frequency; the second number, the expected frequency, is always in parentheses.

***Percentages given here and in subsequent sections show the difference between the percentage expected and the percentage obtained. For example, of the illustrations on which there was No Agreement on objective type, 13.5% were expected to be area 4 but 16.0% were actually obtained. Thus, there were 2.5% more area 4 than expected.

TABLE 78. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Area (square inches)	Point on Scale	Objective Type Agreement		
		None 1	Partial 2	Total 3
0-4	1	-	-	+
5-8	2	-	+	0
9-12	3	+	0*	-
13-17	4	+	-	-
18+	5-9	-	+	-

Objective type agreement by information level. In relation to the instructional illustrations, the frequency of occurrence of information levels was significantly associated with the amount of agreement on objective type ($p < .05$), Table 79. (Two points on one scale were combined to provide adequate expected frequencies.) (See Table 14 for descriptions of points on Information Level Scale and Table 24 for points on Objective Type Agreement Scale.)

Partial Agreement was the most frequently occurring type at each information level.

The largest deviation from expected frequencies for illustrations at each level of agreement was as follows:

---

*In all such tables the zero refers to deviations of 1.0 or less.

TABLE 79. CHI-SQUARE FOR OBJECTIVE SCALE 1: TYPE AGREEMENT AND PHYSICAL SCALE 10: INFORMATION LEVEL

Information Level					Objective Type Agreement			Total
Environment	Shading	Dimensionality	Interior Detail		None 1	Partial 2	Total 3	
Natural	Full	Full	Full	1	98 (101.4)	192 (179.5)	37 (46.1)	327
None	Full	Full	Full	2	10 (12.1)	27 (21.4)	2 (5.5)	39
None	Limited	Limited	Full	3	34 (32.9)	50 (58.2)	22 (15.0)	106
None	None	Limited or None	Limited or None	4,5	87 (83.7)	136 (148.2)	47 (38.1)	270
		Mixed Levels		9	15 (14.0)	27 (24.7)	3 (6.3)	45
		Total			244	432	111	787

$X^2 = 16.6$, $p < .05$

None--1.4% less Level 1 and 1.4% more Level 4,5
Partial--2.8% more Level 1 and 2.8% less Level 4,5
Total--8.3% less Level 1 and 8.0% more Level 4,5

As shown in Table 80 more high information level illustrations (Levels 1 and 2) than expected were associated with Partial Agreement among judges regarding objective type, while more low information level illustrations (Levels 3-5) were associated with both No Agreement and Total Agreement among judges. However, the greater interest (highest percentage of deviations) lies with the Total Agreement category. Associated with Total Agreement were fewer illustrations than expected for high information levels (photographs, for example) and more illustrations than expected of low information levels (drawings, for example, having limited dimensionality and limited interior detail).

(In Table 80 the description of information levels shown in Table 79 has been reduced simply to "high" and "low".)

TABLE 80. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Information Level		Objective Type Agreement		
		None	Partial	Total
High	1	-	+	-
	2	-	+	-
	3	+	-	+
Low	4,5	+	-	+
Mixed	9	0	+	-

In the remaining nine analyses, Objective Type Agreement was non-significantly related to physical type scales as follows:

Framing--Chi-Square 4.65 at 10 df
Configuration--Chi-Square 15.26 at 10 df
Position--Chi-Square 20.22 at 18 df
Elements--Chi-Square 10.52 at 6 df
Chroma--Chi-Square 13.83 at 8 df
Achroma--Chi-Square 14.90 at 10 df
Encoding medium--Chi-Square 8.00 at 6 df
Encoding style--Chi-Square 11.87 at 6 df
Unification--Chi-Square 3.83 at 4 df

Part II

The second objective type scale, Type Pattern, distributed illustrations for which there was Partial or Total Agreement among judges across the five types of objectives. Nine of the 11 physical type scales were significantly associated with this scale, as shown in what follows.

__Objective type pattern by area__. The frequency of occurrence of the sizes of illustrations was significantly associated with the pattern of objective types for the illustrations ($p < .001$), Table 81. (See Table 5 for description of points on Area Scale and Table 25 for description of points on Objective Type Pattern Scale.) (Several points on each scale were combined to provide adequate expected frequencies.)

TABLE 81. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND PHYSICAL SCALE 1: AREA

Area (square inches)		Objective Type Pattern						Total
		Total Agreement and Partial Agreement Among Judges					No Agreement	
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11	
0-4	1	14 (19.8)	22 (19.5)	10 (14.4)	29 (11.6)	11 (16.6)	33 (37.0)	119
5-8	2	20 (15.8)	14 (15.6)	12 (11.5)	13 (9.3)	10 (13.3)	26 (29.6)	95
9-12	3	44 (32.6)	21 (32.1)	22 (23.7)	16 (19.2)	28 (27.4)	65 (61.0)	196
13-17	4	17 (17.6)	12 (17.4)	13 (12.8)	6 (10.4)	19 (14.8)	39 (33.0)	106
18+	5-9	36 (45.1)	60 (44.4)	38 (32.7)	13 (26.5)	42 (37.9)	82 (84.4)	271
Total		131	129	95	77	110	245	787

$X^2 = 65.68$, $p < .001$

For the 542 illustrations on which there was Total or Partial Agreement, the most frequently occurring area of illustrations for each objective type was as follows:

Knowledge--area 3, medium
Analysis--area 5-9, large
Synthesis--area 5-9, large
Application--area 1, small
Appreciation--area 5-9, large

The largest deviation from expected frequencies for illustrations of each objective type (Partial and Total Agreement) was as follows:

Knowledge--8.7% more area 3, medium
Analysis--12.1% more area 5-9, large
Synthesis--5.6% more area 5-9, large
Application--22.6% more area 1, small
Appreciation--5.1% less area 1, small

The deviation of illustration areas from expected frequencies (Table 82), forms a pattern for Knowledge objectives that is essentially the opposite of that for Analysis objectives, while the pattern for Application objectives is essentially the opposite of that for Appreciation.

TABLE 82. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Area (square inches)		Objective Type Pattern					
		Total Agreement and Partial Agreement Among Judges					No Agreement
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11
0-4	1	-	+	-	+	-	-
5-8	2	+	-	0	+	-	-
9-12	3	+	-	-	-	0	+
13-17	4	0	-	0	-	+	+
18+	5-9	-	+	+	-	+	-

Objective type pattern by framing. The frequency of occurrence of framing types was significantly associated with the pattern of objective types for the illustrations ($p < .001$), Table 83. (Several points on each scale were combined to provide adequate expected frequencies. Six cells remained with expected frequencies < 5. Combining categories to reduce the number of such cells from 32 to six did not alter p.) (See Table 6 for description of points on Framing Scale and Table 25 for points on Objective Type Pattern Scale.)

TABLE 83. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND PHYSICAL TYPE 2: FRAMING

Framing		Objective Type Pattern						Total
		Total Agreement and Partial Agreement Among Judges					No Agreement 11	
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10		
Actual-Distinct Line	1	9 (7.7)	14 (7.5)	3 (5.6)	2 (4.5)	1 (6.4)	17 (14.3)	46
Actual-Abrupt Edge	2	48 (32.3)	24 (31.8)	20 (23.4)	12 (19.0)	28 (27.1)	62 (60.4)	194
Actual with Bleed	3	20 (27.6)	32 (27.2)	24 (20.0)	4 (16.2)	33 (23.2)	53 (51.7)	166
Implied with Bleed	4,6	9 (6.8)	5 (6.7)	9 (4.9)	2 (4.0)	6 (5.7)	10 (12.8)	41
Combination and Mixed	5,9	4 (5.7)	9 (5.6)	6 (4.1)	2 (3.3)	4 (4.8)	9 (10.6)	34
Implied	7	41 (50.9)	45 (50.2)	33 (36.9)	55 (29.9)	38 (42.8)	94 (95.3)	306
Total		131	129	95	77	110	245	787

$$x^2 = 78.08, \ p < .001$$

Illustrations with Implied Framing were the most frequently occurring for each objective type except Knowledge for which Actual Framing with abrupt edge occurred most frequently.

The largest deviation from expected frequencies (for illustrations of each objective type) was as follows:

Knowledge--11.9% more Actual, abrupt edge

Analysis--6.1% less Actual, abrupt edge

Synthesis--4.3% more Implied with bleed

Application--32.5% more Implied

Appreciation--8.9% more Actual with bleed

The pattern of deviations, Table 84, was different for each objective type, but there was no consistent tendency toward either actual types or implied types except for No Agreement, and this pattern was supported by very small deviations. The large (32.5%) deviation linking Implied Frames with Application objectives is probably attributable largely to mathematics illustrations.

TABLE 84. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Framing	Objective Type Pattern					
	Total Agreement and Partial Agreement Among Judges					No Agreement 11
	Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	
Actual-Distinct Line 1	+	+	-	-	-	+
Actual-Abrupt Edge 2	+	-	-	-	0	+
Actual with Bleed 3	-	+	+	-	+	+
Implied with Bleed 4,6	+	-	+	-	0	-
Combination and Mixed 5,9	-	+	+	-	0	-
Implied 7	-	-	-	+	-	-

Objective type pattern by configuration. In relation to the instructional illustrations, the frequency of occurrence of configuration types was significantly associated with the pattern of objective types ($p < .001$), Table 85. (Several points on each scale were combined to provide adequate expected frequencies. One cell remained with an expected frequency <5.) (See Table 7 for description of points on Configuration Scale and Table 25 for points on Objective Type Pattern Scales.)

TABLE 85. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND PHYSICAL SCALE 3: CONFIGURATION

Configuration		Objective Type Pattern						Total
		Total Agreement and Partial Agreement Among Judges					No Agreement 11	
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10		
Horizontal Rectangle	2	36 (34.6)	36 (34.1)	26 (25.1)	7 (20.4)	28 (29.1)	75 (64.8)	208
Vertical Rectangle	3	23 (19.3)	19 (19.0)	19 (14.0)	5 (11.3)	18 (16.2)	32 (36.1)	116
Amoeboid, Free-form	6	47 (57.4)	51 (56.6)	42 (41.6)	57 (33.8)	44 (48.2)	104 (107.4)	345
Square, Irregular, Circular & Ellipse, Other	1,4,5,7	22 (12.5)	12 (12.3)	4 (9.1)	6 (7.3)	10 (10.5)	21 (23.3)	75
Mixed	9	3 (7.2)	11 (7.0)	4 (5.2)	2 (4.2)	10 (6.0)	13 (13.4)	43
Total		131	129	95	77	110	245	787

$X^2 = 55.55, p < .001$

The most frequently occurring configuration for all objective types was Amoeboid, Free-form.

The largest deviation from expected frequencies of configuration types (for illustrations of each objective type) was as follows:

Knowledge--7.9% fewer Amoeboid, Free-form

Analysis--4.3% fewer Amoeboid, Free-form

Synthesis--5.3% more Vertical Rectangle; 5.3% fewer Square, Irregular, Circular, Ellipse, and Other

Application--30.2% more Amoeboid, Free-form

Appreciation--3.8% fewer Amoeboid, Free-form

The pattern of deviations, Table 86, shows illustrations with Knowledge objectives to be essentially the inverse in configuration types from those with Application objectives. Most large deviations involved the Amoeboid, Free-form configuration--Application illustrations having many more than expected and Knowledge, Analysis, and Appreciation illustrations having less.

TABLE 86. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Configuration		Objective Type Pattern					
		Total Agreement and Partial Agreement Among Judges					No Agreement 11
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	
Horizontal Rectangle	2	+	+	0	-	-	+
Vertical Rectangle	3	+	0	+	-	+	-
Amoeboid, Free-form	6	-	-	0	+	-	-
Square, Irregular, Circular & Ellipse, Other	1,4,5,7	+	0	-	-	0	-
Mixed	9	-	+	-	-	+	0

Objective type pattern by elements. The frequency of occurrence of types of elements in the illustrations was significantly associated with the pattern of objective types ($p < .001$), Table 87. (Several points on each scale were combined to provide adequate expected frequencies.) (See Table 9 for description of points on Elements Scale and Table 25 for points on Objective Pattern Scale.)

TABLE 87. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND PHYSICAL SCALE 5: ELEMENTS

Elements		Objective Type Pattern						Total
		Total Agreement and Partial Agreement Among Judges					No Agreement 11	
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10		
Pictorial	1	48 (52.6)	41 (51.8)	45 (38.1)	18 (30.9)	74 (44.2)	90 (98.4)	316
Pictorial & Verbal	2	34 (40.8)	44 (40.2)	32 (29.6)	37 (24.0)	24 (34.2)	74 (76.3)	245
Pictorial & Design; Pictorial, Verbal & Design	3,4	49 (37.6)	44 (37.0)	18 (27.3)	22 (22.1)	12 (31.6)	81 (70.4)	226
Total		131	129	95	77	110	245	787

$X^2 = 63.71, p < .001$

The most frequently occurring type of element for illustrations of each objective type was as follows:

Knowledge--combined 3 and 4, i.e., Pictorial and Design; Pictorial, Verbal and Design

Analysis--2, Pictorial and Verbal, and combined 3 and 4, Pictorial and Design; Pictorial, Verbal, and Design

Synthesis--1, Pictorial

Application--2, Pictorial and Verbal

Appreciation--1, Pictorial

The largest deviation from expected frequencies of elements (for illustrations of each objective type) was as follows:

Knowledge--8.7% more combined 3 and 4, Pictorial and Design; Pictorial, Verbal, and Design

Analysis--8.4% less 1, Pictorial

Synthesis--9.8% less combined 3 and 4, Pictorial and Design; Pictorial, Verbal, and Design

Application--17.0% more 2, Pictorial and Verbal; 16.8% less 1, Pictorial

Appreciation--27.1% more 1, Pictorial

The pattern of deviations, Table 88, for Knowledge objectives was the opposite of that for Synthesis objectives; for Analysis objectives the pattern was the opposite of that for Appreciation objectives. The largest deviations were with Application and Appreciation objectives, there being fewer illustrations with only Pictorial elements than expected for Application objectives and more with only Pictorial elements for Appreciation objectives.

TABLE 88. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Elements		Objective Type Pattern					
		Total Agreement and Partial Agreement Among Judges					No Agreement
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11
Pictorial	1	-	-	+	-	+	-
Pictorial & Verbal	2	-	+	+	+	-	-
Pictorial & Design; Pictorial, Verbal & Design	3,4	+	+	-	0	-	+

Objective type pattern by chroma. The frequency of occurrence of chromatic types of illustrations was significantly associated with the pattern of objective types ($p < .001$), Table 89. (Several points on each scale were combined to provide adequate expected frequencies. Two cells remained with expected frequencies <5.) (See Tables 10 and 25 for descriptions of the points on the scales.)

TABLE 89. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND PHYSICAL SCALE 6: CHROMA

Chroma	Objective Type Pattern						Total
	Total Agreement and Partial Agreement Among Judges					No Agreement 11	
	Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10		
Non-chromatic 1	54 (51.1)	53 (50.3)	39 (37.1)	18 (30.0)	48 (42.9)	95 (95.6)	307
Mono-chromatic 2,3 Duo-chromatic	59 (61.4)	60 (60.5)	42 (44.5)	54 (36.1)	34 (51.6)	120 (114.9)	369
Tri-chromatic, 4, Poly-chromatic, 5, Mixed 9	15 (13.3)	11 (13.1)	9 (9.7)	5 (7.8)	18 (11.2)	22 (24.9)	80
Full-chromatic 6	3 (5.2)	5 (5.1)	5 (3.7)	0 (3.0)	10 (4.3)	8 (9.7)	31
Total	131	129	95	77	110	245	787

$X^2 = 39.34$, $p < .001$

Mono-chromatic and Duo-chromatic were the most frequently occurring illustrations for all objective types except for the Appreciation objective for which Non-chromatic occurred most frequently.

The largest deviation from expected frequencies of chromatic types (for illustrations of each objective type) was as follows:

Knowledge--2.2% more Non-chromatic

Analysis--2.1% more Non-chromatic

Synthesis--2.7% less Mono- and Duo-chromatic

Application--23.2% more Mono- and Duo-chromatic; 15.6% less Non-chromatic

Appreciation--16.0% less Mono- and Duo-chromatic

The pattern of deviations, Table 90, indicates that illustrations with Application and Appreciation objectives had opposite chromatic characteristics, there being more Mono- and Duo-chromatic illustrations for Application objectives and more of all the other chromatic types for Appreciation. The latter two objectives also accounted for most of the deviation from expected frequencies. It seems probable that mathematics illustrations were those most heavily involved in the Application deviations.

TABLE 90. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Chroma	Objective Type Pattern					
	Total Agreement and Partial Agreement Among Judges					No Agreement
	Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11
Non-chromatic 1	+	+	+	-	+	0
Mono-chromatic, Duo-chromatic 2,3	-	0	-	+	-	+
Tri-chromatic, Poly-chromatic, Mixed 4, 5, 9	+	-	0	-	+	-
Full-chromatic 6	-	0	+	-	+	-

Objective type pattern by achroma. The frequency of occurrence of achromatic types of illustrations was significantly associated with the pattern of objective types ($p < .001$), Table 91. (Several points on each scale were combined. There remained five cells with expected frequencies < 5.) (See Tables 11 and 25 for descriptions of points on the scales.)

TABLE 91. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND PHYSICAL SCALE 7: ACHROMA

Achroma	Objective Type Pattern						Total
	Total Agreement and Partial Agreement Among Judges					No Agreement 11	
	Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10		
Non-achromatic 1	9 (12.5)	11 (12.3)	12 (9.1)	5 (7.3)	19 (10.5)	19 (23.3)	75
Mono-achromatic 2	52 (51.8)	52 (51.0)	32 (37.5)	47 (30.4)	28 (43.5)	100 (96.8)	311
Duo-achromatic 3	17 (15.0)	18 (14.8)	5 (10.9)	11 (8.8)	9 (12.6)	30 (28.0)	90
Tri-achromatic Poly-achromatic 4,5	28 (23.6)	28 (23.3)	26 (17.1)	10 (13.9)	11 (19.8)	39 (44.2)	142
Full-achromatic 6	22 (23.8)	12 (23.4)	18 (17.3)	3 (14.0)	38 (20.0)	50 (44.5)	143
Mixed-achromatic 9	3 (4.3)	8 (4.3)	2 (3.1)	1 (2.5)	5 (3.6)	7 (8.1)	26
Total	131	129	95	77	110	245	787

$X^2 = 80.85$, $p < .001$

Mono-achromatic illustrations were the most frequently occurring for each objective type except Appreciation, for which Full-achromatic occurred most frequently.

The largest deviation from expected frequencies of achromatic types (for illustrations of each objective type) was as follows:

Knowledge--3.4% more Tri- and Poly-achromatic

Analysis--8.9% less Full-achromatic

Synthesis--9.4% more Tri- and Poly-achromatic

Application--21.5% more Mono-achromatic; 14.3% fewer Full-achromatic

Appreciation--14.0% fewer Mono-achromatic; 16.3% more Full-achromatic

As shown in Table 92, the pattern of deviations for illustrations having Knowledge and Analysis objectives was similar while the pattern for Application objectives was in contrast to that for Appreciation. The largest deviations were for Application and Appreciation objectives, there being more Mono-achromatic illustrations (probably a drawing with black lines) for Application objectives and more Full-achromatic illustrations (probably a black and white photo) for Appreciation objectives.

TABLE 92. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Achroma		Objective Type Pattern					
		Total Agreement and Partial Agreement Among Judges					No Agreement
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11
Non-achromatic	1	-	-	+	-	+	-
Mono-achromatic	2	0	0	-	+	-	+
Duo-achromatic	3	+	+	-	+	-	+
Tri-achromatic Poly-achromatic	4,5	+	+	+	-	-	-
Full-achromatic	6	-	-	0	-	+	+
Mixed-achromatic	9	-	+	-	-	+	-

Objective type pattern by encoding medium. In relation to the instructional illustrations, the frequency of occurrence of encoding media types was significantly associated with the pattern of objective types ($p < .001$), Table 93. (Several points on one scale were combined. There remained three cells with expected frequencies < 5.) (See Tables 12 and 25 for descriptions of points on the scales.)

TABLE 93. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND PHYSICAL SCALE 8: ENCODING MEDIUM

Encoding Medium	Objective Type Pattern						Total
	Total Agreement and Partial Agreement Among Judges					No Agreement	
	Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11	
Photographic 1	24 (29.5)	18 (29.0)	24 (21.4)	3 (17.3)	47 (24.7)	61 (55.1)	177
Artistic, Two-Dimensional 2	65 (59.9)	56 (59.0)	50 (43.5)	32 (35.2)	51 (50.3)	106 (112.1)	360
Mechanical 3	37 (35.8)	45 (35.2)	20 (26.0)	40 (21.0)	4 (30.1)	69 (66.9)	215
Mixed 9	5 (5.8)	10 (5.7)	1 (4.2)	2 (3.4)	8 (4.9)	9 (10.9)	35
Total	131	129	95	77	110	245	787

$X^2 = 92.71$, $p < .001$

Illustrations in the Artistic medium were the most frequently occurring for all objective types except for Application, for which illustrations in the Mechanical medium were the most frequent.

The largest deviation from expected frequencies of encoding media (for illustrations of each objective type) was as follows:

Knowledge--4.2% fewer Photographic; 3.9% more Artistic
Analysis--8.5% fewer Photographic; 7.6% more Mechanical
Synthesis--6.9% more Artistic; 6.2% fewer Mechanical
Application--18.6% fewer Photographic; 24.6% more Mechanical
Appreciation--20.2% more Photographic; 23.7% fewer Mechanical

As shown in Table 94, the pattern of deviations for Analysis illustrations was the opposite of that for Synthesis illustrations, there being more Mechanical and Mixed media for Analysis than expected and more Photographic and Artistic for Synthesis than expected. The largest deviations were for illustrations with Photographic and Mechanical media together with Application and Appreciation objectives, Application illustrations being more frequently Mechanical than expected and Appreciation illustrations being more frequently Photographic than expected.

TABLE 94. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Encoding Medium		Objective Type Pattern					
		Total Agreement and Partial Agreement Among Judges					No Agreement
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11
Photographic	1	-	-	+	-	+	+
Artistic, Two-Dimensional	2	+	-	+	-	0	-
Mechanical	3	+	+	-	+	-	+
Mixed	9	0	+	-	-	+	-

Objective type pattern by encoding style. The frequency of occurrence of encoding styles of illustrations was significantly associated with the pattern of objective types ($p < .001$), Table 95.

TABLE 95. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND PHYSICAL SCALE 9: ENCODING STYLE

Encoding Style		Objective Type Pattern						Total
		Total Agreement and Partial Agreement Among Judges					No Agreement	
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11	
Realistic	1	62 (72.1)	62 (71.0)	57 (52.3)	30 (42.4)	92 (60.5)	130 (134.8)	433
Cartoon	2	11 (6.5)	6 (6.4)	4 (4.7)	1 (3.8)	7 (5.5)	10 (12.1)	39
Diagrammatic	3	52 (46.6)	53 (45.9)	30 (33.8)	43 (27.4)	5 (39.1)	97 (87.2)	280
Other	4,5,9	6 (5.8)	8 (5.7)	4 (4.2)	3 (3.4)	6 (4.9)	8 (10.9)	35
Total		131	129	95	77	110	245	787

$X^2 = 73.18$, $p < .001$

(Several points on each scale were combined. There remained five cells with expected frequencies <5.) (See Tables 13 and 25 for descriptions of the points on the scales.)

Realistic style illustrations were the most frequently occurring for all objective types except Application, for which the most frequent was Diagrammatic style.

The largest deviation from expected frequencies of encoding styles (for illustrations of each objective type) was as follows:

Knowledge--7.7% fewer Realistic
Analysis--6.9% fewer Realistic; 5.5% more Diagrammatic
Synthesis--5.0% more Realistic; 4.0% fewer Diagrammatic
Application--20.2% more Diagrammatic; 16.0% fewer Realistic
Appreciation--31.1% fewer Diagrammatic; 28.6% more Realistic

As shown in Table 96, Knowledge, Analysis, and Application objectives were characterized by fewer Realistic and more Diagrammatic style illustrations, while the opposite held for Synthesis and Appreciation, with more Realistic and fewer Diagrammatic illustrations. The largest deviations were for illustrations having Application and Appreciation objectives together with Realistic and Diagrammatic styles.

TABLE 96. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Encoding Style	Objective Type Pattern					
	Total Agreement and Partial Agreement Among Judges					No Agreement 11
	Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	
Realistic 1	-	-	+	-	+	-
Cartoon 2	+	0	0	-	+	-
Diagrammatic 3	+	+	-	+	-	+
Other 4,5,9	0	+	0	0	+	-

Objective type pattern by information level. The frequency of occurrence of illustrations at various information levels was significantly associated with the pattern of objective types ($p < .001$), Table 97. (Points on each scale were combined to provide adequate expected frequencies. Three cells remained with expected frequencies < 5.) (See Tables 14 and 25 for descriptions of points on both scales. Description of points on the Information Level Scale have been greatly simplified in Table 97.)

TABLE 97. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND PHYSICAL SCALE 10: INFORMATION LEVEL

Information Level		Objective Type Pattern						Total
		Total Agreement and Partial Agreement Among Judges					No Agreement 11	
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10		
High	1	52 (54.4)	49 (53.6)	49 (39.5)	10 (32.0)	69 (45.7)	98 (101.8)	327
	2	7 (6.5)	2 (6.4)	4 (4.7)	8 (3.8)	8 (5.5)	10 (12.1)	39
	3	24 (17.6)	12 (17.4)	13 (12.8)	10 (10.4)	13 (14.8)	34 (33.0)	106
Low	4,5	43 (44.9)	53 (44.3)	26 (32.6)	47 (26.4)	13 (37.7)	88 (84.1)	270
Mixed	9	5 (7.5)	13 (7.4)	3 (5.4)	2 (4.4)	7 (6.3)	15 (14.0)	45
Total		131	129	95	77	110	245	787

$X^2 = 86.73$, $p < .001$

The most frequently occurring information level for Knowledge, Synthesis, and Appreciation objectives was level 1, High, while the most frequently occurring for Analysis and Application objectives was level 4 and 5, Low.

The largest deviation from expected frequencies of information levels (for illustrations of each objective type) was as follows:

Knowledge--4.8% more level 3, Medium
Analysis--6.8% more level 4 and 5, Low
Synthesis--10.0% more level 1, High
Application--28.6% less level 1, High; 26.7% more level 4 and 5, Low
Appreciation--21.1% more level 1, High; 22.5% less level 4 and 5, Low

The pattern of deviations, Table 98, appears somewhat different for illustrations of each objective type. Analysis and Appreciation were in contrast, there being fewer High information level illustrations than expected with Analysis objectives and more than expected with Appreciation objectives. The largest deviations were for illustrations having Application and Appreciation objectives together with High and Low information levels.

TABLE 98. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Information Level		Objective Type Pattern					
		Total Agreement and Partial Agreement Among Judges					No Agreement 11
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	
High	1	-	-	+	-	+	-
	2	0	-	0	+	+	-
	3	+	-	0	0	-	0
Low	4,5	-	+	-	+	-	+
Mixed	9	-	+	-	-	0	0

For the remaining two analyses, Objective Type Pattern was non-significantly related to physical type scales as follows:

Position--Chi-Square 55.59 at df 45

Unification--Chi-Square 11.33 at df 10

Part III

The third objective type scale, Best Type, distributed illustrations across the five objective types according to a judge's choice of most appropriate or "best" from among the three objectives written by teachers for each illustration. Ten of the 11 physical type scales were significantly associated with this scale, as shown in the analyses to follow.

Best objective type by area. With reference to the instructional illustrations, the frequency of occurrence of sizes of areas was significantly associated with the types of educational objectives ($p < .001$), Table 99. (Several points on one scale were combined.) (See Table 5

TABLE 99. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND PHYSICAL SCALE 1: AREA

Area (square inches)		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
0-4	1	22 (30.7)	23 (29.3)	21 (20.9)	35 (14.2)	18 (23.9)	119
5-8	2	26 (24.5)	21 (23.4)	13 (16.7)	22 (11.3)	13 (19.1)	95
9-12	3	65 (50.6)	41 (48.3)	29 (34.4)	18 (23.4)	43 (39.3)	196
13-17	4	28 (27.3)	24 (26.1)	23 (18.6)	5 (12.7)	26 (21.3)	106
18+	5-9	62 (69.9)	85 (66.8)	52 (47.5)	14 (32.4)	58 (54.4)	271
Total		203	194	138	94	158	787

$X^2 = 80.27$, $p < .001$

for description of points on Area Scale and Table 26 for points on Best Objective Type Scale.)

For each type of objective, the most frequently occurring area of illustrations was as follows:

Knowledge--area 3, medium
Analysis--area 5-9, large
Synthesis--area 5-9, large
Application--area 1, small
Appreciation--area 5-9, large

The largest deviation from expected frequencies of areas (for illustrations of each objective type) was as follows:

Knowledge--7.1% more area 3, medium
Analysis--9.4% more area 5-9, large
Synthesis--3.9% fewer area 3, medium
Application--22.1% more area 1, small and 19.5% fewer area 5-9, large
Appreciation--3.9% fewer area 2

The pattern of deviations, Table 100, appears to be characteristic for illustrations of each objective type with smaller areas for Knowledge and Application objectives and larger areas for Analysis, Synthesis, and Appreciation.

TABLE 100. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Area (square inches)		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
0-4	1	-	-	0	+	-
5-8	2	+	-	-	+	-
9-12	3	+	-	-	-	+
13-17	4	0	-	+	-	+
18+	5,9	-	+	+	-	+

Best objective type by framing. In relation to the instructional illustrations, the frequency of occurrence of framing types was significantly associated with educational objective types ($p < .001$), Table 101. (Several points on one scale were combined. Two cells remained with expected frequencies < 5.) (See Tables 6 and 26 for descriptions of points on the scales.)

TABLE 101. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND PHYSICAL SCALE 2: FRAMING

Framing		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
Actual--Distinct Line	1	13 (11.9)	17 (11.3)	6 (8.1)	6 (5.5)	4 (9.2)	46
Actual--Abrupt Edge	2	68 (50.0)	35 (47.8)	33 (34.0)	12 (23.2)	46 (38.9)	194
Actual with Bleed	3	39 (42.8)	46 (40.9)	33 (29.1)	4 (19.8)	44 (33.3)	166
Implied with Bleed	4,6	11 (10.6)	13 (10.1)	8 (7.2)	0 (4.9)	9 (8.2)	41
Combination and Mixed	5,9	7 (8.8)	13 (8.4)	4 (6.0)	3 (4.1)	7 (6.8)	34
Implied	7	65 (78.9)	70 (75.4)	54 (53.7)	69 (36.5)	48 (61.4)	306
Total		203	194	138	94	158	787

$X^2 = 84.93$, $p < .001$

The most frequently occurring type of framing (for illustrations of each objective type) was as follows:

Knowledge--Actual, abrupt edge

Analysis--Implied

Synthesis--Implied

Application--Implied

Appreciation--Implied

For illustrations of each objective type, the largest deviation from expected frequencies of framing types was as follows:

Knowledge--8.8% more Actual, abrupt edge
Analysis--6.7% fewer Actual, abrupt edge
Synthesis--2.8% more Actual with bleed
Application--34.5% more Implied; 16.8% less Actual with bleed
Appreciation--8.5% fewer Implied

The patterns of deviation, Table 102, appear to vary according to each objective. The two largest deviations were for illustrations with Application objectives.

TABLE 102. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Framing		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
Actual-Distinct Line	1	+	+	-	0	-
Actual-Abrupt Edge	2	+	-	0	-	+
Actual with Bleed	3	-	+	+	-	+
Implied with Bleed	4,6	0	+	0	-	0
Combination and Mixed	5,9	-	+	-	-	0
Implied	7	-	-	0	+	-

Best objective type by configuration. With regard to the instructructional illustrations, the frequency of occurrence of types of configurations was significantly associated with the types of educational objectives ($p < .001$), Table 103. (Several points on one scale were combined. Three cells remained with expected frequencies < 5. Further combining of points to eliminate these did not alter p.) (See Tables 7 and 26 for descriptions of points on the scales.)

TABLE 103. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND PHYSICAL SCALE 3: CONFIGURATION

Configuration		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
Square	1	11 (5.7)	3 (5.4)	1 (3.9)	3 (2.6)	4 (4.4)	22
Horizontal Rectangle	2	53 (53.7)	58 (51.3)	41 (36.5)	7 (24.8)	49 (41.8)	208
Vertical Rectangle	3	44 (29.9)	20 (28.6)	19 (20.3)	4 (13.9)	29 (23.3)	116
Amoeboid, Free-form	6	75 (89.0)	84 (85.0)	61 (60.5)	68 (41.2)	57 (69.3)	345
Irregular, Circular and Ellipse, Other	4,5, 7	16 (13.7)	13 (13.1)	8 (9.3)	8 (6.3)	8 (10.6)	53
Mixed shapes	9	4 (11.1)	16 (10.6)	8 (7.5)	4 (5.1)	11 (8.6)	43
Total		203	194	138	94	158	787

$X^2 = 73.21, p < .001$

The most frequently occurring type of configuration for illustrations of all objective types was point 6, Amoeboid, Free-form.

The largest deviation from expected frequencies of configuration types (for illustrations of each objective type) was as follows:

Knowledge--7.0% more Vertical Rectangle; 6.9% less Amoeboid, Free-form

Analysis--4.4% fewer Vertical Rectangle

Synthesis--3.3% more Horizontal Rectangle

Application--28.5% more Amoeboid, Free-form; 19.0% fewer Horizontal Rectangle

Appreciation--7.7% fewer Amoeboid, Free-form

The pattern of deviations for configuration types, Table 104, varied according to the objective type of the illustration. The

TABLE 104. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Configuration		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
Square	1	+	-	-	0	0
Horizontal Rectangle	2	0	+	+	-	+
Vertical Rectangle	3	+	-	-	-	+
Amoeboid, Free-form	6	-	0	0	+	-
Irregular, Circular and Ellipse, Other	4,5, 7	+	0	-	+	-
Mixed Shapes	9	-	+	0	-	+

pattern for Application objectives was the inverse of that for Appreciation. The two largest deviations were for Application objectives.

Best objective type by position. The frequency of occurrence of types of positions for the illustrations was significantly associated with the types of educational objectives ($p < .001$), Table 105. (Many points on one scale were combined to provide adequate expected frequencies.) (See Table 8 and Figure 8 for descriptions of the points on the Position Scale.)

The most frequently occurring position for illustrations of each objective type was as follows:

Knowledge--D,E,F--upper right, middle right, or lower right on page

Analysis--ABDE--upper 2/3 of page

Synthesis--ABDE--upper 2/3

Application--D,E,F--upper right, middle right, or lower right of page

Appreciation--ABDE--upper 2/3

TABLE 105. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND PHYSICAL SCALE 4: POSITION

Position		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
A,B,C,	1-3	16 (17.8)	15 (17.0)	14 (12.1)	16 (8.2)	8 (13.9)	69
D,E,F	4-6	30 (27.9)	20 (26.6)	16 (18.9)	18 (12.9)	24 (21.7)	108
AD	8	25 (20.1)	15 (19.2)	13 (13.7)	5 (9.3)	20 (15.7)	78
AB, BC	7 & 9	20 (13.4)	11 (12.8)	7 (9.1)	2 (6.2)	12 (10.4)	52
BE, CF	10-11	21 (20.9)	24 (20.0)	10 (14.2)	16 (9.7)	10 (16.3)	81
DE, EF	12-13	22 (18.8)	9 (18.0)	15 (12.8)	9 (8.7)	18 (14.7)	73
3 Area Combinations	14-23, 42	8 (11.3)	14 (10.8)	6 (7.7)	10 (5.3)	6 (8.8)	44
4-5 Area Combinations	24-26 28-30 32-41,43	14 (19.9)	23 (19.0)	19 (13.5)	4 (9.2)	17 (15.5)	77
ABDE	27	24 (31.5)	39 (30.1)	22 (21.4)	9 (14.6)	28 (24.5)	122
BCEF	31	23 (21.4)	24 (20.5)	16 (14.6)	5 (9.9)	15 (16.7)	83
Total		203	194	138	94	158	787

$X^2 = 68.17, p < .001$

For illustrations of each objective type, the largest deviation from expected frequencies of positions was as follows:

Knowledge--3.7% less ABDE, upper 2/3 of page

Analysis--4.7% less DE, EF, upper right 2/3, lower right 2/3

Synthesis--4.0% more combinations of 4 and 5 areas (other than ABDE and BCEF)

Application--8.2% more A, B, C, upper left, middle left, or lower left

Appreciation--4.0% less BE, CF, middle or lower 1/3

The patterns of deviation, Table 106, were difficult to interpret, partly because of the necessary combination of categories and partly because the position scale included a size dimension. It can be seen, for example, that position AD, upper 1/3, was roughly half as large as position ABDE, upper 2/3. Because size factors have already been considered for Physical Scale 1: Area, the following brief discussion will be between positions of the same size.

TABLE 106. DIRECTION OF DEVIATIONS OF ACTUAL FREQUENCIES FROM EXPECTED

Position		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
A,B,C,	1-3	-	-	+	+	-
D,E,F	4-6	+	-	-	+	+
AD	8	+	-	0	-	+
AB, BC	7 & 9	+	-	-	-	+
BE, CF	10-11	0	+	-	+	-
DE, EF	12-13	+	-	+	0	+
3 Area Combinations	14-23, 42	-	+	-	+	-
4-5 Area Combinations	24-26 28-30 32-41,43	-	+	+	-	+
ABDE	27	-	+	0	-	+
BCEF	31	+	+	+	-	-

Single areas (points 1-6) showed pattern similarities between Knowledge and Appreciation objectives (preference for right side) and pattern contrasts between Analysis and Application. The latter reflected the size differences noted previously for Physical Scale 1: Area, there being fewer small illustrations with Analysis objectives than expected and more with Application objectives.

Double areas (points 8-13) again showed pattern similarities between Knowledge and Appreciation objectives, there being more illustrations than expected in all positions except BE and CF, middle and bottom third, respectively. In contrast, illustrations with Analysis and Application objectives occurred less frequently in all positions except BE and CF.

Three to five area combinations mainly reflected size differences, there being more illustrations with Analysis objectives than expected and fewer with Application objectives.

Best objective type by elements. With reference to the instructional illustrations, the frequency of occurrence of types of elements (Pictorial, Verbal, Design) was significantly associated with the types of educational objectives ($p < .001$), Table 107. (Three of 20 cells had expected frequencies < 5. Combining points on one of the scales eliminated the low expected frequencies but did not alter p.) (See Tables 9 and 26 for descriptions of the points on each scale.)

For illustrations at each type of objective, the most frequently occurring type of element was as follows:

Knowledge--Pictorial only
Analysis--Pictorial and Verbal
Synthesis--Pictorial only
Application--Pictorial and Verbal
Appreciation--Pictorial only

TABLE 107. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND PHYSICAL SCALE 5: ELEMENTS

Elements		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
Pictorial	1	76 (81.5)	64 (77.9)	61 (55.4)	16 (37.7)	99 (63.4)	316
Pictorial and Verbal	2	55 (63.2)	67 (60.4)	39 (43.0)	47 (29.3)	37 (49.2)	245
Pictorial and Design	3	68 (52.4)	56 (50.0)	33 (35.6)	27 (24.2)	19 (40.8)	203
Pictorial, Verbal and Design	4	4 (5.9)	7 (5.7)	5 (4.0)	4 (2.7)	3 (4.6)	23
Total		203	194	138	94	158	787

$X^2 = 71.59$, $p < .001$

The largest deviation from expected frequencies of types of elements (for illustrations of each objective type) was as follows:

Knowledge--7.7% more Pictorial and Design
Analysis--7.2% fewer Pictorial only
Synthesis--4.0% more Pictorial only
Application--23.2% fewer Pictorial only; 18.9% more Pictorial and Verbal
Appreciation--22.5% more Pictorial only; 13.8% fewer Pictorial and Design

The pattern of deviations, Table 108, suggests that more illustrations than expected with Pictorial elements only were associated with Synthesis and Appreciation objectives, while more illustrations with Pictorial and other elements (Verbal and/or Design) were associated with Analysis and Application objectives. For Knowledge objectives there were fewer than expected of all types of elements except Pictorial and Design.

TABLE 108. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Elements		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
Pictorial	1	-	-	+	-	+
Pictorial and Verbal	2	-	+	-	+	-
Pictorial and Design	3	+	+	-	+	-
Pictorial, Verbal and Design	4	-	+	0	+	-

Best objective type by chroma. With reference to the instructional illustrations, the frequency of occurrence of chromatic types was significantly associated with educational objective types (p <.001), Table 109. (Four cells had expected frequencies <5. Further reduction

TABLE 109. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND PHYSICAL SCALE 6: CHROMA

Chroma		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
Non-chromatic	1	84 (79.2)	72 (75.7)	50 (53.8)	24 (36.7)	77 (61.6)	307
Mono-chromatic and Duo-chromatic	2, 3	97 (95.2)	93 (91.0)	66 (64.7)	63 (44.1)	50 (74.1)	369
Tri-chromatic and Poly-chromatic	4, 5	17 (15.0)	16 (14.3)	7 (10.2)	4 (6.9)	14 (11.6)	58
Full-chromatic	6	4 (8.0)	6 (7.6)	10 (5.4)	1 (3.7)	10 (6.2)	31
Mixed-chromatic	9	1 (5.7)	7 (5.4)	5 (3.9)	2 (2.6)	7 (4.4)	22
Total		203	194	138	94	158	787

$X^2 = 44.95$, $p < .001$

in the number of such cells by combining points on one of the scales did not alter p.) (See Tables 10 and 26 for descriptions of points on the scales.)

The most frequently occurring chromatic type (for illustrations of each objective type) was as follows:

Knowledge--Mono- and Duo-chromatic
Analysis--Mono- and Duo-chromatic
Synthesis--Mono- and Duo-chromatic
Application--Mono- and Duo-chromatic
Appreciation--Non-chromatic

The largest deviation from expected frequencies of chromatic types (for illustrations of each objective type) was as follows:

Knowledge--2.4% more Non-chromatic; 2.3% less Mixed-chromatic
Analysis--1.9% less Non-chromatic
Synthesis--3.3% more Full-chromatic
Application--20.1% more Mono- and Duo-chromatic; 13.5% less Non-chromatic
Appreciation--15.3% fewer Mono- and Duo-chromatic; 9.7% more Non-chromatic

The pattern of deviations from expected frequencies of chromatic types, Table 110, was different for illustrations of each objective type, Application objectives having the inverse pattern of Appreciation. Full-chromatic illustrations were more frequently associated with Synthesis and Appreciation objectives than expected. Non-chromatic illustrations were more frequently associated with Knowledge and Appreciation objectives than expected.

TABLE 110. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Chroma		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
Non-chromatic	1	+	-	-	-	+
Mono-chromatic and Duo-chromatic	2, 3	+	+	+	+	-
Tri-chromatic and Poly-chromatic	4, 5	+	+	-	-	+
Full-chromatic	6	-	-	+	-	+
Mixed-chromatic	9	-	+	+	0	+

Best objective type by achroma. With reference to the instructional illustrations, the frequency of occurrence of achromatic types was significantly associated with educational objective types ($p < .001$), Table 111. (Two points on one scale were combined. Two cells had expected frequencies <5.) (See Tables 11 and 26 for descriptions of points on the scales.)

The most frequently occurring type was Mono-achromatic for illustrations of all objective types except Appreciation, for which the most frequent was Full-achromatic.

The largest deviation from expected frequencies of achromatic types (for illustrations of each objective type) was as follows:

Knowledge--3.6% fewer Non-achromatic; 3.7% more Tri- and Poly-achromatic

Analysis--4.3% more Mono-achromatic; 4.3% fewer Full-achromatic

Synthesis--6.3% fewer Mono-achromatic

Application--26.5% more Mono-achromatic; 16.1% fewer Full-achromatic

Appreciation--13.6% fewer Mono-achromatic; 14.1% more Full-achromatic

TABLE 111. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND PHYSICAL SCALE 7: ACHROMA

Achroma		Best Objective Type					Total
		Knowl-edge 1	Anal-ysis 2	Syn-thesis 3	Appli-cation 4	Appre-ciation 5	
Non-achromatic	1	12 (19.3)	14 (18.5)	18 (13.2)	9 (9.0)	22 (15.1)	75
Mono-achromatic	2	77 (80.2)	85 (76.7)	46 (54.5)	62 (37.1)	41 (62.4)	311
Duo-achromatic	3	25 (23.2)	26 (22.2)	15 (15.8)	10 (10.7)	14 (18.1)	90
Tri-achromatic and Poly-achromatic	4, 5	44 (36.6)	34 (35.0)	29 (24.9)	10 (17.0)	25 (28.5)	142
Full-achromatic	6	40 (36.9)	27 (35.3)	23 (25.1)	2 (17.1)	51 (28.7)	143
Mixed-achromatic	9	5 (6.7)	8 (6.4)	7 (4.6)	1 (3.1)	5 (5.2)	26
Total		203	194	138	94	158	787

$X^2 = 79.06$, $p < .001$

According to Table 112, the pattern of deviations from expected frequencies for illustrations with Analysis objectives was essentially

TABLE 112. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Achroma		Best Objective Type				
		Knowl-edge 1	Anal-ysis 2	Syn-thesis 3	Appli-cation 4	Appre-ciation 5
Non-achromatic	1	-	-	+	0	+
Mono-achromatic	2	-	+	-	+	-
Duo-achromatic	3	+	+	0	0	-
Tri-achromatic and Poly-achromatic	4, 5	+	0	+	-	-
Full-achromatic	6	+	-	-	-	+
Mixed-achromatic	9	-	+	+	-	0

the inverse of those with Appreciation objectives, being more Mono-, Duo-, and Mixed-achromatic for Analysis objectives than expected and more Non- and Full-achromatic for Appreciation than expected. The largest deviations were for illustrations with Application and Appreciation objectives together with Mono- and Full-achroma. Full-achromatic illustrations were associated more frequently than expected with both Knowledge and Appreciation objectives.

Best objective type by encoding medium. With reference to the instructional illustrations, the frequency of occurrence of types of encoding media was significantly associated with types of educational objectives ($p <.001$), Table 113. (One cell had an expected frequency <5.) (See Tables 12 and 26 for descriptions of points on scales.)

TABLE 113. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND PHYSICAL SCALE 8: ENCODING MEDIUM

Encoding Medium		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
Photographic	1	44 (45.7)	37 (43.6)	33 (31.0)	3 (21.1)	60 (35.5)	177
Artistic, Two-Dimensional	2	96 (92.9)	83 (88.7)	69 (63.1)	34 (43.0)	78 (72.3)	360
Mechanical	3	56 (55.5)	65 (53.0)	29 (37.7)	55 (25.7)	10 (43.2)	215
Mixed	9	7 (9.0)	9 (8.6)	7 (6.1)	2 (4.2)	10 (7.0)	35
Total		203	194	138	94	158	787

$X^2 = 103.64$, $p <.001$

The most frequently occurring encoding medium was Artistic, Two-Dimensional for illustrations of each objective type except Application, for which the most frequent was Mechanical.

The largest deviation from expected frequencies of encoding media (for illustrations of each objective type) was as follows:

Knowledge--1.6% more Artistic, Two-Dimensional
Analysis--6.2% more Mechanical
Synthesis--6.3% fewer Mechanical
Application--31.2% more Mechanical; 19.3% less Photographic
Appreciation--21.0% fewer Mechanical; 15.5% more Photographic

As shown in Table 114, the encoding media which were associated more frequently than expected with each objective were: Artistic for Knowledge objectives; Mechanical for Analysis objectives; and Photographic and Artistic, for Synthesis objectives. The pattern for Application objectives was the inverse of that for Appreciation objectives, there being more Mechanical for Application than expected and more of all the other types for Appreciation objectives. Largest deviations

TABLE 114. DIRECTION OF DEVIATIONS OF ACTUAL FREQUENCIES FROM EXPECTED

Encoding Medium		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
Photographic	1	-	-	+	-	+
Artistic, Two-Dimensional	2	+	-	+	-	+
Mechanical	3	0	+	-	+	-
Mixed	9	-	0	0	-	+

were with Application and Appreciation objectives and Photographic and Mechanical media.

Best objective type by encoding style. The frequency of occurrence of the encoding styles of illustrations was significantly associated with objective types for the illustrations ($p <.001$), Table 115. (Two of the 20 cells had expected frequencies <5. Several points were combined on one scale.) (See Tables 13 and 26 for descriptions of points on the scales.)

TABLE 115. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND PHYSICAL SCALE 9: ENCODING STYLE

Encoding Style		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
Realistic	1	102 (111.7)	100 (106.7)	76 (75.9)	29 (51.7)	126 (86.9)	433
Cartoon	2	14 (10.1)	8 (9.6)	6 (6.8)	2 (4.7)	9 (7.8)	39
Diagrammatic	3	79 (72.2)	79 (69.0)	46 (49.1)	60 (33.4)	16 (56.2)	280
Other	4,5,9	8 (9.0)	7 (8.6)	10 (6.1)	3 (4.2)	7 (7.0)	35
Total		203	194	138	94	158	787

$X^2 = 87.73$, $p <.001$

The most frequently occurring style for the sample (Realistic Style) was also the most frequent for each objective except Application, for which it was Diagrammatic style.

The largest deviation from expected frequencies of encoding styles (for illustrations of each objective type) was as follows:

Knowledge--4.8% less Realistic
Analysis--5.1% more Diagrammatic
Synthesis--2.8% more Other
Application--28.2% more Diagrammatic; 24.1% fewer Realistic
Appreciation--25.5% fewer Diagrammatic; 24.7% more Realistic

Table 116 shows that associated with Analysis and Application objectives were more Diagrammatic style illustrations than expected and less of all other types. Conversely, with Appreciation objectives were associated fewer Diagrammatic and the same or more of all other types than expected. The largest deviation from expected frequencies was for illustrations with Realistic and Diagrammatic styles and with Application and Appreciation objectives.

TABLE 116. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Encoding Style		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
Realistic	1	-	-	0	-	+
Cartoon	2	+	-	0	-	+
Diagrammatic	3	+	+	-	+	-
Other	4,5,9	0	-	+	-	0

Best objective type by information level. In relation to the instructional illustrations, the frequency of occurrence of information levels was significantly associated with the types of objectives ($p < .001$), Table 117. (One of the 25 cells had an expected frequency <5. Two points on one scale were combined.) (See Tables 14 and 26 for descriptions of points on the scales. The Information Level Scale has been greatly simplified in Table 117.)

TABLE 117. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND PHYSICAL SCALE 10: INFORMATION LEVEL

Information Level		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
High	1	83 (84.3)	76 (80.6)	61 (57.3)	8 (39.1)	99 (65.6)	327
	2	12 (10.1)	8 (9.6)	6 (6.8)	8 (4.7)	5 (7.8)	39
	3	31 (27.3)	24 (26.1)	18 (18.6)	13 (12.7)	20 (21.3)	106
Low	4,5	69 (69.6)	72 (66.6)	43 (47.3)	62 (32.2)	24 (54.2)	270
Mixed	9	8 (11.6)	14 (11.1)	10 (7.9)	3 (5.4)	10 (9.0)	45
Total		203	194	138	94	158	787

$X^2 = 95.82, p <.001$

Illustrations with a Low information level were the most frequently occurring for Application objectives, while those with a High information level were most frequent for each of the other objectives.

The largest deviation from expected frequencies of information levels (for illustrations of each objective type) was as follows:

Knowledge--1.8% more 3, Medium level; 1.8% less 9, Mixed levels
Analysis--2.8% more 4,5, Low level
Synthesis--3.1% less 4,5, Low level
Application--31.7% more 4,5, Low level; 33.1% less 1, High level
Appreciation--19.1% less 4,5, Low level; 21.1% more 1, High level

As shown in Table 118 more Low information level illustrations than expected were associated with Analysis objectives, while more High information level illustrations were associated with Synthesis objectives.

TABLE 118. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Information Level		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
High	1	-	-	+	-	+
	2	+	-	0	+	-
	3	+	-	0	0	-
Low	4,5	0	+	-	+	-
Mixed	9	-	+	+	-	0

The contrast between Application and Appreciation objectives was even more pronounced, more illustrations of Medium to Low information level than expected being related to Application objectives and more of High information level being related to Appreciation objectives. The largest deviations from expected frequencies were for illustrations with Application and Appreciation objectives and with High and Low levels of information.

For a more adequate definition of Information Level see Chapter IV and Appendix F.

Best objective type by unification. This relationship was found to be non-significant, the Chi-Square being 11.27 at 8 df.

Part IV

The fourth objective type scale, Level Agreement, measured the amount of agreement among three teachers as to the level of difficulty (degree of learner involvement) in meeting each objective. Two of the

11 physical scales were significantly associated with this scale, as shown in the analyses to follow.

Objective level agreement by elements. With reference to the instructional illustrations, the frequency of occurrence of types of elements (Pictorial, Verbal, Design) was significantly associated with the amounts of agreement on objective level ($p < .05$), Table 119. (One cell had an expected frequency < 5. Combining points on one scale to eliminate that cell changed p to .01.) (See Tables 9 and 27 for descriptions of points on the scales.)

TABLE 119. CHI-SQUARE FOR OBJECTIVE SCALE 4: LEVEL AGREEMENT AND PHYSICAL SCALE 5: ELEMENTS

Elements		Objective Level Agreement			Total
		None 1	Partial 2	Total 3	
Pictorial	1	95(104.8)	185(177.5)	36(33.7)	316
Pictorial and Verbal	2	78(81.3)	131(137.6)	36(26.1)	245
Pictorial and Design	3	79(67.3)	114(114.0)	10(21.7)	203
Pictorial, Verbal and Design	4	9(7.6)	12(12.9)	2(2.5)	23
Total		261	442	84	787

$$X^2 = 14.24, \; p < .05$$

The most frequently occurring type of element (for illustrations at each amount of agreement on objective level) was as follows:

No Agreement--Pictorial
Partial Agreement--Pictorial
Total Agreement--Pictorial

The largest deviation from expected frequencies of types of elements (for illustrations at each amount of agreement on objective level) was as follows:

No Agreement--4.5% more Pictorial and Design elements
Partial Agreement--1.7% more Pictorial only
Total Agreement--13.9% fewer Pictorial and Design elements; 11.8% more Pictorial and Verbal

The pattern of deviations, Table 120, suggests that more illustrations than expected with Pictorial elements only and Pictorial and Verbal elements were associated with Total Agreement on objective level, while more than expected with Pictorial and Design elements and Pictorial, Verbal, and Design elements were associated with No Agreement. The largest deviations were with Total Agreement.

TABLE 120. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Elements		Objective Level Agreement		
		None 1	Partial 2	Total 3
Pictorial	1	-	+	+
Pictorial and Verbal	2	-	-	+
Pictorial and Design	3	+	0	-
Pictorial, Verbal and Design	4	+	0	0

Objective level agreement by encoding style. The frequency of occurrence of the encoding styles of illustrations was significantly associated with the amounts of judge agreement on objective level for the illustrations ($p < .01$). (Two of the 12 cells had expected frequencies <5.)

As Table 121 shows, Realistic style illustrations were the most

TABLE 121. CHI-SQUARE FOR OBJECTIVE SCALE 4: LEVEL AGREEMENT AND PHYSICAL SCALE 9: ENCODING STYLE

Encoding Style		Objective Level Agreement			Total
		None 1	Partial 2	Total 3	
Realistic	1	134(143.6)	253(243.2)	46(46.2)	433
Cartoon	2	21(12.9)	16(21.9)	2(4.2)	39
Diagrammatic	3	86(92.9)	160(157.3)	34(29.9)	280
Other	4,5,9	20(11.6)	13(19.7)	2(3.7)	35
Total		261	442	84	787

$X^2 = 19.03,\ p < .01$

frequently occurring at each amount of agreement on objective level.

The largest deviation from expected frequencies of encoding styles (for each amount of agreement on objective level) was as follows:

No Agreement--3.7% less Realistic; 3.3% more Other
Partial Agreement--2.2% more Realistic
Total Agreement--2.6% less Cartoon; 4.9% more Diagrammatic

Table 122 shows that Realistic and Diagrammatic style illustrations were the same or greater in frequency than expected for Partial

TABLE 122. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Encoding Style		Objective Level Agreement		
		None 1	Partial 2	Total 3
Realistic	1	-	+	0
Cartoon	2	+	-	-
Diagrammatic	3	-	+	+
Other	4,5,9	+	-	-

and Total judge agreements while Cartoon and Other style illustrations were associated more frequently than expected with the lack of judge agreement.

For the remaining nine analyses, Objective Level Agreement was non-significantly related to physical type scales as follows:

Area--Chi-Square 11.55 at 8 df
Framing--Chi-Square 6.08 at 10 df
Configuration--Chi-Square 11.56 at 10 df
Position--Chi-Square 18.45 at 18 df
Chroma--Chi-Square 8.41 at 8 df
Achroma--Chi-Square 16.99 at 10 df
Encoding medium--Chi-Square 6.54 at 6 df
Information level--Chi-Square 13.13 at 8 df
Unification--Chi-Square 7.44 at 4 df

Part V

The fifth objective type scale, Best Level, measured on a five-point scale the level of difficulty (degree of learner involvement) in meeting each objective. Ten of the 11 physical type scales were significantly associated with this scale. (For all analyses, points 1 and 2 were combined and 4 and 5 were combined to eliminate expected frequencies <2.)

Best objective level by framing. The frequency of occurrence of framing types for illustrations was significantly associated with the levels of the objectives ($p < .001$), Table 123. (Several points on each scale were combined.) (See Tables 28 and 6 for descriptions of points on scales.)

TABLE 123. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND PHYSICAL SCALE 2: FRAMING

Framing		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
Actual-Distinct Line	1	14(17.1)	18(18.5)	14(10.3)	46
Actual-Abrupt Edge	2	82(72.2)	75(78.1)	37(43.6)	194
Actual with Bleed	3	79(61.8)	62(66.9)	25(37.3)	166
Implied with Bleed	4,6	15(15.3)	22(16.5)	4(9.2)	41
Combination and Mixed	5,9	7(12.7)	17(13.7)	10(7.6)	34
Implied	7	96(113.9)	123(123.3)	87(68.8)	306
Total		293	317	177	787

$X^2 = 30.00$, $p < .001$

Implied framing was the most frequently occurring type for illustrations at all objective levels.

The largest deviation from expected frequencies of framing types (for illustrations at each objective level) was as follows:

Limited--6.1% fewer Implied; 5.9% more Actual with bleed
Average--1.7% more Implied with bleed
Extensive--10.3% more Implied; 7.0% fewer Actual with bleed

The pattern of deviations, Table 124, suggests a tendency for more illustrations with Actual frames (points 2 and 3) to be associated with Limited level objectives while more with Combination and Mixed (5, 9) and Implied with Bleed (4, 6, 7) to be associated with Average or Extensive level objectives. The largest deviations were with Limited and Extensive levels and with Implied frames and Actual frames with bleed.

TABLE 124. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Framing		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
Actual-Distinct Line	1	-	0	+
Actual-Abrupt Edge	2	+	-	-
Actual with Bleed	3	+	-	-
Implied with Bleed	4,6	0	+	-
Combination and Mixed	5,9	-	+	+
Implied	7	-	0	+

Best objective level by configuration. The frequency of occurrence of types of configurations for the illustrations was significantly associated with the levels of the objectives ($p < .02$), Table 125.

TABLE 125. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND PHYSICAL SCALE 3: CONFIGURATION

Configuration		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
Horizontal Rectangle	2	94(77.4)	78(83.8)	36(46.8)	208
Vertical Rectangle	3	50(43.2)	48(46.7)	18(26.1)	116
Amoeboid, Free-form	6	111(128.4)	141(139.0)	93(77.6)	345
Square, Irregular, Circular and Ellipse, Other	1,4, 5,7	28(27.9)	29(30.2)	18(16.9)	75
Mixed	9	10(16.0)	21(17.3)	12(9.7)	43
Total		293	317	177	787

$X^2 = 19.22$, $p < .02$

(Several points on each scale were combined.) (See Tables 28 and 7 for descriptions of points on scales.)

The Amoeboid, Free-form configuration was the most frequently occurring for all objective levels.

The largest deviation from expected frequencies of configuration types (for illustrations of each objective level) was as follows:

Limited--5.9% fewer Amoeboid, Free-form; 5.7% more Horizontal Rectangle

Average--1.8% fewer Horizontal Rectangle

Extensive--8.7% more Amoeboid, Free-form; 6.1% fewer Horizontal Rectangle

The pattern of deviations, Table 126, shows there to be more illustrations than expected with Horizontal and Vertical Rectangle configurations associated with Limited level objectives, while there were more than expected with Amoeboid, Free-form and all other types associated with Extensive level objectives. The greatest deviations are with Limited and Extensive levels and with Horizontal Rectangle and Amoeboid, Free-form configurations.

TABLE 126. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Configuration		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
Horizontal Rectangle	2	+	-	-
Vertical Rectangle	3	+	+	-
Amoeboid, Free-form	6	-	+	+
Square, Irregular, Circular and Ellipse, Other	1,4, 5,7	0	-	+
Mixed	9	-	+	+

Best objective level by position. The frequency of occurrence of types of positions for the illustrations was significantly associated with the levels of the objectives ($p < .01$), Table 127. (Several points on each scale were combined to eliminate expected frequencies <2. Before combining, the p was $> .05$. It was non-significant.) (See Tables 28 and 8 for descriptions of points on scales.)

TABLE 127. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND PHYSICAL SCALE 4: POSITION

Position		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
A,B,C,	1-3	29(25.7)	25(27.8)	15(15.5)	69
D,E,F	4-6	45(40.2)	41(43.5)	22(24.3)	108
AD	8	34(29.0)	31(31.4)	13(17.5)	78
AB, BC	7 & 9	24(19.4)	19(20.9)	9(11.7)	52
BE, CF	10-11	37(30.2)	27(32.6)	17(18.2)	81
DE, EF	12-13	25(27.2)	28(29.4)	20(16.4)	73
3 Area Combinations	14-23 42	11(16.4)	23(17.7)	10(9.9)	44
4-5 Area Combinations	24-26 28-30, 32-41,43	16(28.7)	28(31.0)	33(17.3)	77
ABDE	27	44(45.4)	56(49.1)	22(27.4)	122
BCEF	31	28(30.9)	39(33.4)	16(18.7)	83
Total		293	317	177	787

$\chi^2 = 36.31$, $p < .01$

The most frequently occurring position for illustrations at each objective level was as follows:

Limited--D,E,F--upper right, middle right, or lower right of page
Average--ABDE--upper 2/3 of page
Extensive--4-5 Area combinations except ABDE and BCEF

The largest deviation from expected frequencies of types of positions (for illustrations of each objective level) was as follows:

Limited--4.3% fewer 4-5 Area combinations
Average--2.2% more ABDE
Extensive--8.8% more 4-5 Area combinations

The pattern of deviations, Table 128, suggests a tendency for more smaller illustrations than expected (single area positions, points 1-6, and double areas, points 7-11) to be associated with Limited

TABLE 128. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Position		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
A,B,C	1-3	+	-	0
D,E,F	4-6	+	-	-
AD	8	+	0	-
AB, BC	7 & 9	+	-	-
BE, CF	10-11	+	-	-
DE, EF	12-13	-	-	+
3 Area Combinations	14-23 42	-	+	0
4-5 Area Combinations	24-26 28-30 32-41,43	-	-	+
ABDE	27	-	+	-
BCEF	31	-	+	-

objective levels and more larger illustrations (3, 4, and 5 Area combinations) to be associated with Average and Extensive objective levels. However, these differences must be in part attributable to position on the page instead of size because the size scale, Physical Scale 1: Area, was not significantly associated with objective level. The largest deviations were for large illustrations only, those which were combinations of 4-5 areas.

Best objective level by elements. With reference to the instructional illustrations, the frequency of occurrence of types of elements (Pictorial, Verbal, Design) was significantly associated with the levels of the objectives ($p < .001$), Table 129. (Several points on each scale were combined.) (See Tables 28 and 9 for descriptions of points on scales.)

TABLE 129. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND PHYSICAL SCALE 5: ELEMENTS

Elements		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
Pictorial	1	161(117.6)	116(127.3)	39(71.1)	316
Pictorial and Verbal	2	75(91.2)	96(98.7)	74(55.1)	245
Pictorial and Design; Pictorial, Verbal and Design	3,4	57(84.1)	105(91.0)	64(50.8)	226
Total		293	317	177	787

$$X^2 = 55.19, \ p < .001$$

For illustrations at each objective level, the most frequently occurring type of element was as follows:

Limited--Pictorial only

Average--Pictorial only

Extensive--Pictorial and Verbal

The largest deviation from expected frequencies of types of elements (for illustrations at each level of objective) was as follows:

Limited--14.7% more 1, Pictorial; 9.2% fewer combined 3 and 4, Pictorial and Design; Pictorial, Verbal and Design

Average--4.4% more combined 3 and 4, Pictorial and Design; Pictorial, Verbal and Design

Extensive--18.2% fewer 1, Pictorial; 10.7% more 2, Pictorial and Verbal

The pattern of deviations, Table 130, suggests that more illustrations than expected which had Pictorial elements only were associated with the lower (1 and 2) levels of objectives, while more illustrations with Pictorial and other elements (Verbal and/or Design) were associated with average or higher (3-5) levels of objectives. The largest deviations were with illustrations having Pictorial elements only, there being more than expected at low objective levels and fewer at high levels.

TABLE 130. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Elements		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
Pictorial	1	+	-	-
Pictorial and Verbal	2	-	-	+
Pictorial and Design; Pictorial, Verbal and Design	3,4	-	+	+

Best objective level by chroma. With reference to the instructional illustrations, the frequency of occurrence of chromatic types was significantly associated with the levels of the objectives (p <.001), Table 131. (Several points on each scale were combined.) (See Tables 28 and 10 for descriptions of points on scales.)

TABLE 131. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND PHYSICAL SCALE 6: CHROMA

Chroma		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
Non-chromatic	1	146(114.3)	114(123.7)	47(69.0)	307
Mono-chromatic, Duo-chromatic	2,3	113(137.4)	157(148.6)	99(83.0)	369
Tri-chromatic, Poly-chromatic, Mixed-chromatic	4,5 & 9	20(29.8)	35(32.2)	25(18.0)	80
Full-chromatic	6	14(11.5)	11(12.5)	6(7.0)	31
Total		293	317	177	787

$X^2 = 31.49$, p <.001

The most frequently occurring chromatic type for illustrations at each level of objective was as follows:

Limited--Non-chromatic
Average--Mono- and Duo-chromatic
Extensive--Mono- and Duo-chromatic

The largest deviation from expected frequencies of chromatic types (for illustrations at each level objective) was as follows:

Limited--10.8% more Non-chromatic; 8.3% less Mono- and Duo-chromatic

Average--3.0% less Non-chromatic

Extensive--12.4% less Non-chromatic; 9.0% more Mono- and Duo-chromatic

The pattern of deviations, Table 132, showed that Levels 1 and 2 were the inverse of Levels 3, 4 and 5, Levels 1 and 2 having more Non-chromatic and Full-chromatic illustrations than expected and Levels 3, 4 and 5 having more Mono-chromatic to Poly-chromatic and Mixed-chromatic than expected. The largest deviations were for Non-chromatic and Mono- and Duo-chromatic illustrations at Limited and Extensive levels.

TABLE 132. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Chroma		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
Non-chromatic	1	+	-	-
Mono-chromatic, Duo-chromatic	2,3	-	+	+
Tri-chromatic, Poly-chromatic, Mixed-chromatic	4,5 & 9	-	+	+
Full-chromatic	6	+	-	0

Best objective level by achroma. With reference to the instructional illustrations, the frequency of occurrence of achromatic types was significantly associated with the levels of objectives ($p < .001$), Table 133. (Several points on each scale were combined.) (See Tables 28 and 11 for descriptions of points on scales.)

Mono-achromatic illustrations were the most frequently occurring for each level of objective.

TABLE 133. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND PHYSICAL SCALE 7: ACHROMA

Achroma		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
Non-achromatic	1	28(27.9)	30(30.2)	17(16.9)	75
Mono-achromatic	2	97(115.8)	130(125.3)	84(69.9)	311
Duo-achromatic	3	26(33.5)	31(36.3)	33(20.2)	90
Tri-achromatic, Poly-achromatic	4,5	57(52.9)	59(57.2)	26(31.9)	142
Full-achromatic	6	82(53.2)	49(57.6)	12(32.2)	143
Mixed-achromatic	9	3(9.7)	18(10.5)	5(5.8)	26
Total		293	317	177	787

$$X^2 = 57.62, \ p < .001$$

The largest deviation from expected frequencies of achromatic types (for illustrations at each objective level) was as follows:

Limited--9.8% more Full-achromatic; 6.4% less Mono-achromatic
Average--2.7% fewer Full-achromatic
Extensive--11.4% fewer Full-achromatic; 8.0% more Mono-achromatic

The pattern of deviations, Table 134, suggests that in general more illustrations of the Tri-, Poly- and Full-achromatic types than expected were associated with lower level objectives (1 and 2), while more illustrations of the Mono- and Duo-achromatic types than expected were associated with higher level objectives (4 and 5). The largest deviations were for Mono- and Full-achromatic illustrations at Limited and Extensive objective levels.

TABLE 134. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Achroma		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
Non-achromatic	1	0	0	0
Mono-achromatic	2	-	+	+
Duo-achromatic	3	-	-	+
Tri-achromatic, Poly-achromatic	4,5	+	+	-
Full-achromatic	6	+	-	-
Mixed-achromatic	9	-	+	0

Best objective level by encoding medium. With reference to the instructional illustrations, the frequency of occurrence of types of encoding media was significantly associated with the levels of the objectives ($p < .001$), Table 135. (Several points on one scale were

TABLE 135. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND PHYSICAL SCALE 8: ENCODING MEDIUM

Encoding Medium		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
Photographic	1	100(65.9)	60(71.3)	17(39.8)	177
Artistic, Two-Dimensional	2	137(134.0)	146(145.0)	77(81.0)	360
Mechanical	3	49(80.0)	94(86.6)	72(48.4)	215
Mixed	9	7(13.0)	17(14.1)	11(7.9)	35
Total		293	317	177	787

$X^2 = 61.63$, $p < .001$

combined.) (See Tables 28 and 12 for descriptions of points on scales.)

Artistic was the most frequently occurring encoding medium for illustrations at each level of objective.

The largest deviation from expected frequencies of types of encoding media (for illustrations of each objective level) was as follows:

Limited--10.6% fewer Mechanical; 11.6% more Photographic
Average--3.6% fewer Photographic
Extensive--12.9% fewer Photographic; 13.4% more Mechanical

The pattern of deviations, Table 136, suggests that more Photographic and Artistic illustrations than expected were associated with

TABLE 136. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Encoding Medium		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
Photographic	1	+	-	-
Artistic, Two-Dimensional	2	+	0	-
Mechanical	3	-	+	+
Mixed	9	-	+	+

Limited level objectives (1 and 2), while more Mechanical and Mixed media illustrations than expected were associated with Average and Extensive level objectives (3-5). Largest deviations were for Photographic and Mechanical media and Extensive and Limited objectives.

Best objective level by encoding style. The frequency of occurrence of the encoding styles of the illustrations was significantly associated with the objective levels of the illustrations ($p < .001$), Table 137. (Several points were combined on each scale.) (See Tables 28 and 13 for descriptions of points on scales.)

TABLE 137. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND PHYSICAL SCALE 9: ENCODING STYLE

Encoding Style		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
Realistic	1	204(161.2)	165(174.4)	64(97.4)	433
Cartoon	2	12(14.5)	16(15.7)	11(8.8)	39
Diagrammatic	3	69(104.2)	121(112.8)	90(63.0)	280
Other	4,5,9	8(13.0)	15(14.1)	12(7.9)	35
Total		293	317	177	787

$X^2 = 52.59$, $p < .001$

Realistic style illustrations were the most frequently occurring for Limited or Average levels of objectives, while Diagrammatic style illustrations were more frequent for Extensive objective levels.

The largest deviation from expected frequency (for illustrations at each objective level) was as follows:

Limited--14.6% more Realistic; 12.1% fewer Diagrammatic
Average--2.9% fewer Realistic
Extensive--18.8% fewer Realistic; 15.2% more Diagrammatic

As shown in Table 138, more Realistic style illustrations than expected were associated with Limited level objectives, while more Diagrammatic, Cartoon, and Other style illustrations than expected were associated with Extensive level objectives. The larger deviations were for Realistic and Diagrammatic style illustrations at Limited and Extensive levels.

TABLE 138. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Encoding Style		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
Realistic	1	+	-	-
Cartoon	2	-	0	+
Diagrammatic	3	-	+	+
Other	4,5,9	-	0	+

Best objective level by information level. The frequency of occurrence of the information levels of the illustrations was significantly associated with the levels of involvement required of the students to meet the objectives for the illustrations ($p < .001$), Table 139.

TABLE 139. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND PHYSICAL SCALE 10: INFORMATION LEVEL

Information Level		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
High	1	159(121.7)	127(131.7)	41(73.5)	327
	2	16(14.5)	13(15.7)	10(8.8)	39
	3	39(39.5)	40(42.7)	27(23.8)	106
Low	4,5	72(100.5)	112(108.8)	86(60.7)	270
Mixed	9	7(16.8)	25(18.1)	13(10.1)	45
Total		293	317	177	787

$$X^2 = 55.17,\ p < .001$$

(Points were combined on each scale.) (See Tables 14 and 28 for descriptions of points on scales. Points on Information Level Scale have been greatly simplified in Table 139.)

High information level illustrations were the most frequently occurring at all objective levels except Extensive, for which the most frequent was Low information level.

The largest deviation from expected frequencies (for illustrations at each objective level) was as follows:

Limited--12.7% more High level; 9.7% fewer Low level
Average--2.2% more Mixed
Extensive--18.4% fewer High level; 14.3% more Low level

As shown in Table 140, more of the higher information level (points 1 and 2) illustrations than expected had Limited level objectives, while more of the lower information level (points 3-5) and Mixed (point 9) illustrations than expected had Average to Extensive level objectives. There appeared to be an inverse relation between the information level of an illustration and the level of the objective assigned to it.

TABLE 140. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Information Level		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
High	1	+	-	-
	2	+	-	+
	3	0	-	+
Low	4,5	-	+	+
Mixed	9	-	+	+

Best objective level by unification. The frequency of occurrence of the degrees of unification of the illustrations was significantly associated with the levels of involvement required of the students to meet the objectives for the illustrations ($p < .001$), Table 141. (Several points were combined on each scale.) (See Tables 28 and 15 for descriptions of points on scales.)

TABLE 141. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND PHYSICAL SCALE 11: UNIFICATION

Unification		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
Full	1	265(245.3)	258(265.4)	136(148.2)	659
Partial	2	25(38.7)	48(41.9)	31(23.4)	104
Some to None	3,4,5	3(8.9)	11(9.7)	10(5.4)	24
Total		293	317	177	787

$X^2 = 19.06$, $p < .001$

Full unification was the most frequently occurring type for illustrations at all objective levels.

The largest deviation from expected frequencies of unification levels (for illustrations at each objective level) was as follows:

Limited--6.7% more Full unification; 4.7% less Partial
Average--2.3% less Full unification
Extensive--6.9% less Full unification; 4.3% more Partial

As shown in Table 142, more of the fully unified illustrations than expected had Limited level objectives, while more of the less unified (points 2-5) illustrations than expected had Average and Extensive level objectives.

TABLE 142. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Unification		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
Full	1	+	-	-
Partial	2	-	+	+
Some to None	3,4,5	-	+	+

Objective level by area. This relationship was found to be non-significant, the Chi-Square being 12.8 at 8 df.

Summary. The amount of agreement between judges of objectives, whether for objective type or level, was generally not related to the physical attributes of the illustrations (9 of 11 scales). However, the type of objectives judged appropriate for the illustrations was generally found to be significantly related to the physical attributes of the illustrations (9 or 10 of 11 scales). Likewise, the judged difficulty level (level of involvement) of the objectives was generally found to be significantly related to the physical attributes of the illustrations (10 of 11 scales).

The two scales assessing objective types (Type Pattern and Best Type) were in essential agreement as to whether or not the relationships were significant (10 of 11 scales). In all analyses of objective type that yielded significant differences, the largest deviations from expected frequencies were either for Application or Appreciation objectives, in most cases Application objectives (7 scales). The pattern of deviations for Application was essentially the opposite of that for

Appreciation in six scales. The pattern of deviations for Analysis was essentially the same as that for Application in the three scales.

In all analyses of objective level, regardless of the associated physical type, the largest deviations from expected frequencies were for the Extensive level and the next largest were either for the Extensive or the Limited level.

It was of interest to note whether there was any tendency for the deviations of actual from expected frequencies of physical types of illustrations to form patterns, i.e., for the deviations for one objective type to be alike or unlike those for other objective types. The most frequently occurring pattern (22% of the cases) was one in which Knowledge, Analysis, and Application deviations were in one direction, while Synthesis and Appreciation objectives were in the other. The next most frequently occurring pattern (16%) was one in which Knowledge and Application deviations were in one direction, while Analysis, Synthesis, and Appreciation objectives were in the other. The next most frequently occurring pattern (14%) was one in which Knowledge and Appreciation deviations were in one direction, while Analysis, Synthesis, and Application deviations were in the other. These three patterns accounted for over half of the cases.

The Coefficients of Contingency for the smallest and largest X^2 in this section are as follows:

C = .13 for Objective Level Agreement by Elements

C = .34 for Best Objective Type by Encoding Medium.

In addition to the emphasis given to statistically significant differences in the above summary and in the preceding discussions of each Chi-Square analysis, it may be of interest to consider the frequency data without regard to its significance. It would be possible from these data to describe the most probable (most frequently occurring) physical characteristics of an illustration for each type of educational objective. For example the "typical" Application illustration would: be small size (0-4 square inches); have an Implied frame; be Amoeboid, Free-form in configuration; be located in the bottom 1/3 of the page; contain both Pictorial and Verbal elements; have one or two colors; be Mono-achromatic; be in a Mechanical medium; have a Diagrammatic style; be devoid of natural environment; have no shading; have limited or no dimensionality; and have limited or no interior detail.

Table 143 gives comparable information about the most frequently occurring point on each physical scale for the other four types of objectives. For example, for Physical Scale 7: Achroma the most frequently occurring type for Analysis illustrations was point 2, Mono-achromatic (black or one shade of grey). One could say that the typical (most frequently occurring) Analysis illustration was Mono-achromatic, or that 44% of Analysis illustrations were Mono-achromatic, or that .44 was the best estimate of the probability that an illustration in the population which had an Analysis objective would be Mono-achromatic. Note that although the Mono-achromatic condition was most frequent for four objective types, the associated percentages varied, that for Application illustrations being the highest at 66%. Thus, the percentages serve as an estimate of the predictive value of the attribute.

It should be emphasized that the data in Table 143 may or may not be related to the statistical significances found. They simply give

TABLE 143. MOST FREQUENTLY OCCURRING POINT ON PHYSICAL TYPE SCALES FOR ILLUSTRATIONS OF EACH OBJECTIVE TYPE AND PERCENTAGE OF ILLUSTRATIONS OF EACH OBJECTIVE TYPE THAT WERE AT THAT POINT

Physical Type	Best Objective Type									
	Knowledge		Analysis		Synthesis		Application		Appreciation	
	Point	Per cent	Point	Per cent	Point	Per cent	Point	Per cent	Point	Per cent
1. Area	3, Medium	32	5-9, Large	44	5-9, Large	38	1, Small	37	5-9, Large	37
2. Framing	2, Actual	68	7, Implied	70	7, Implied	54	7, Implied	69	7, Implied	48
3. Configuration	6, Amoeboid	37	6, Amoeboid	43	6, Amoeboid	44	6, Amoeboid	72	6, Amoeboid	36
4. Position	8, Upper 1/3	12	27, Upper 2/3	20	27, Upper 2/3	16	11, Bottom 1/3	13	27, Upper 2/3	18
5. Elements	1, Pictorial	37	2, Pictorial and Verbal	35	1, Pictorial	44	2, Pictorial and Verbal	50	1, Pictorial	63
6. Chroma	2-3, Mono- & Duo-chromatic	48	2-3, Mono- & Duo-chromatic	48	2-3, Mono- & Duo-chromatic	48	2-3, Mono- & Duo-chromatic	67	1, Non-chromatic	49
7. Achroma	2, Mono-achromatic	38	2, Mono-achromatic	44	2, Mono-achromatic	33	2, Mono-achromatic	66	6, Full-achromatic	32
8. Medium	2, Artistic	47	2, Artistic	43	2, Artistic	50	3, Mechanical	59	2, Artistic	49
9. Style	1, Realistic	50	1, Realistic	52	1, Realistic	55	3, Diagrammatic	64	1, Realistic	80
10. Information	1, High	41	1, High	39	1, High	44	4,5 Low	66	1, High	63
11, Unification	1, Full	86	1, Full	82	1, Full	80	1, Full	81	1, Full	89

for illustrations of each objective type (columns) the most frequently occurring point on each physical scale (rows) and the percentage of such illustrations. For a more adequate description of the physical scale points, see Chapter IV and Appendix F.

It would also be possible from the data to describe the most probable (most frequently occurring) physical characteristics of an illustration at each level of difficulty (level of student involvement in meeting the objective). For example, the "typical" Limited level (low level) illustration would: be large size; have an Implied frame; be Amoeboid or Free-form in configuration; be in the upper right middle right or lower right position on the page; have Pictorial elements only; have no color; be Mono-achromatic; be in an Artistic medium; have a Realistic style; have a High information level; and be fully unified.

The most frequently occurring physical type for each level of objective is given in Table 144. The point number on each physical scale is given and an abbreviated description. See Chapter IV and Appendix F to avoid misinterpretation of the descriptions. Also given in Table 144 are the percentages of illustrations at each objective level (columns) which are at the indicated point on each physical scale (rows).

In sum the 32 analyses reveal systematic differences in the physical attributes of illustrations as a function of the type and level of the educational objectives they might serve. In a way, these data constitute "hypotheses" stating that the learning necessary to meet each type and level of objective can be optimized by

TABLE 144. MOST FREQUENTLY OCCURRING POINT ON PHYSICAL TYPE SCALES FOR ILLUSTRATIONS OF EACH OBJECTIVE LEVEL AND PERCENTAGE OF ILLUSTRATIONS OF EACH OBJECTIVE LEVEL THAT WERE AT THAT POINT

Physical Type	Best Objective Level					
	Limited		Average		Extensive	
	Point	Per cent	Point	Per cent	Point	Per cent
1. Area	5-9, Large	30	5-9, Large	36	5-9, Large	39
2. Framing	7, Implied	33	7, Implied	39	7, Implied	49
3. Configuration	6, Amoeboid	38	6, Amoeboid	45	6, Amoeboid	53
4. Position	4-6, Right	15	27, Upper 2/3	18	4-5 Area Combination	19
5. Elements	1, Pictorial	55	1, Pictorial	37	2, Pictorial and Verbal	42
6. Chroma	1, Non-chromatic	50	2,3, Mono- & Duo-chromatic	50	2,3, Mono- & Duo-chromatic	56
7. Achroma	2, Mono-achromatic	33	2, Mono-achromatic	41	2, Mono-achromatic	48
8. Medium	2, Artistic	47	2, Artistic	46	2, Artistic	44
9. Style	1, Realistic	70	1, Realistic	52	3, Diagrammatic	50
10. Information	1, High	54	1, High	40	4,5 Low	49
11. Unification	1, Full	90	1, Full	81	1, Full	77

illustrations having certain physical attributes. These hypotheses may suggest directions for future research.

Analyses of Objective Types by Verbal Modifier Types

The 25 Chi-Square analyses that follow test the independence of five verbal modifier scales from the five objective type scales. They deal with the question: were the verbal modifiers of the illustrations related to the educational objectives assigned to those illustrations? In approximately 60% of the cases, the relationships were found to be statistically significant.

Part I

The first objective type scale, Type Agreement, measured the degree of agreement among the three judges as to the most appropriate type of objective for each illustration. Only one of the verbal modifier scales was significantly associated with this scale, as shown in what follows.

Objective type agreement by non-sentence quantity. In relation to the instructional illustrations, the frequency of occurrence of non-sentences was significantly associated with the amount of agreement on objective types ($p < .01$), Table 145. (Two of 30 cells had expected frequencies <5.)

The largest deviation from expected frequencies of non-sentence quantities (for illustrations at each amount of agreement on objective type) was as follows:

TABLE 145. CHI-SQUARE FOR OBJECTIVE SCALE 1: TYPE AGREEMENT AND VERBAL MODIFIER SCALE 4: NON-SENTENCE QUANTITY

Non-sentence Quantity		Objective-type Agreement			Total
		None* 1	Partial 2	Total 3	
None*	1	57(60.8)**	114(107.6)	25(27.6)	196
One	2	48(43.4)	78(76.8)	14(19.7)	140
Two	3	23(26.4)	52(46.7)	10(12.0)	85
Three and Four	4	18(25.1)	46(44.5)	17(11.4)	81
Five and Six	5	22(18.6)	35(32.9)	3(8.5)	60
Seven and Eight	6	20(15.8)	20(28.0)	11(7.2)	51
9-12	7	18(17.4)	25(30.7)	13(7.9)	56
13-21	8	10(16.1)	29(28.5)	13(7.3)	52
22-41	9	17(10.5)	15(18.7)	2(4.8)	34
42+	10	11(9.9)	18(17.6)	3(4.5)	32
Total		244	432	111	787

$X^2 = 36.92$, $p < .01$

No Agreement--2.9% fewer Three and Four***

Partial Agreement--1.9% fewer Seven and Eight

Total Agreement--5.2% fewer One; 5.1% more 13-21

The pattern of deviations, Table 146, suggests that fewer illustrations than expected with 0-4 non-sentences were associated with No Agreement on objective type, more illustrations than expected with 0-6

---

*Names and numbers refer to points on scales. See Tables 24 and 32 for description of points on scales.

**The first numbers are actual frequencies; the second numbers (in parenthesis) are expected (theoretical) frequencies.

***Percentages given here and in subsequent sections show the differences between the percentage expected and the percentage obtained. For example, of the illustrations on which there was No Agreement on objective type, 10.3% were expected to have three or four non-sentence modifiers but 7.4% were actually obtained. Thus, there were 2.9% fewer illustrations than expected with three or four non-sentence modifiers.

TABLE 146. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Non-sentence Quantity		Objective-type Agreement		
		None 1	Partial 2	Total 3
None	1	-	+	-
One	2	+	+	-
Two	3	-	+	-
Three and Four	4	-	+	+
Five and Six	5	+	+	-
Seven and Eight	6	+	-	+
9-12	7	0*	-	+
13-21	8	-	0	+
22-41	9	+	-	-
42+	10	+	0	-

non-sentences were associated with Partial Agreement on objective type, and fewer illustrations than expected with 0-2 and 22-42+ non-sentences and more than expected with 7-21 non-sentences were associated with Total Agreement on objective type. In general, the smaller quantities of non-sentences were associated with Partial Agreement while the larger quantities were associated with No Agreement or Total Agreement.

In the remaining four analyses, Objective Type Agreement was non-significantly related to verbal modifier scales as follows:

Verbal Modifier Type--Chi-Square 5.41 at 6 df
Sentence Pattern--Chi-Square 9.66 at 10 df
Non-sentence Pattern--Chi-Square 4.08 at 8 df
Sentence Quantity--Chi-Square 8.36 at 14 df

---

*Zero refers to deviations of 1.0 or less.

Part II

The second objective type scale, Type Pattern, distributed illustrations (for which there was partial or total agreement among judges) across the five objective types. All five of the verbal modifier scales were significantly associated with the scale, as shown in the analyses to follow.

Objective type pattern by verbal modifier type. In relation to the instructional illustrations, the frequency of occurrence of verbal modifiers was significantly associated with the patterns of objective types ($p < .001$), Table 147. (Several points were combined on one scale. One cell remained with expected frequencies <5.) (See Tables 25 and 29 for descriptions of points on scales.)

TABLE 147. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND VERBAL MODIFIER SCALE 1: TYPE

Verbal Modifier Type		Objective Type Pattern						
		Total Agreement and Partial Agreement Among Judges					No Agreement	Total
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11	
None	1	1 (7.2)	1 (7.0)	7 (5.2)	5 (4.2)	16 (6.0)	13 (13.4)	43
Sentence	2	27 (25.5)	27 (25.1)	26 (18.5)	7 (15.0)	22 (21.4)	44 (47.6)	153
Non-sentence	3	44 (29.5)	27 (29.0)	10 (21.4)	6 (17.3)	38 (24.7)	52 (55.1)	177
Both	4	59 (68.9)	74 (67.9)	52 (50.0)	59 (40.5)	34 (57.9)	136 (128.9)	414
Total		131	129	95	77	110	245	787

$X^2 = 84.51, p < .001$

The most frequently occurring verbal modifier was point 4, Both Sentence and Non-sentence, for illustrations of all objective types except Appreciation, for which the most frequent was point 3, Non-sentence.

The largest deviation from expected frequencies of verbal modifiers (for illustrations of each objective type) was as follows:

Knowledge--11.1% more Non-sentences
Analysis--4.8% more Both
Synthesis--12.0% fewer Non-sentences
Application--24.0% more Both; 14.7% fewer Non-sentences
Appreciation--21.7% fewer Both; 12.0% more Non-sentences

As shown in Table 148 there appears to be a characteristic pattern of deviations for illustrations of each objective type.

TABLE 148. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Verbal Modifier Type		Objective Type Pattern					
		Total Agreement and Partial Agreement Among Judges					No Agreement
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11
None	1	-	-	+	0	+	0
Sentence	2	+	+	+	-	0	-
Non-sentence	3	+	-	-	-	+	-
Both	4	-	+	+	+	-	+

Objective type pattern by sentence pattern. In relation to the instructional illustrations, the frequency of occurrence of sentence patterns was significantly associated with the pattern of objective types

($p < .001$), Table 149. (Several points on each scale were combined. Two cells remained with expected frequencies < 5.) (See Tables 25 and 31 for descriptions of points on scales.)

TABLE 149. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND VERBAL MODIFIER SCALE 3: SENTENCE PATTERN

Sentence Pattern		Objective Type Pattern						Total
		Total Agreement and Partial Agreement Among Judges					No Agreement	
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11	
None	1	45 (36.3)	27 (35.7)	16 (26.3)	11 (21.3)	54 (30.5)	65 (67.9)	218
Declarative	2	55 (50.3)	51 (49.5)	47 (36.5)	5 (29.5)	47 (42.2)	97 (94.0)	302
Interrogative, Imperative, or Other	3-5	8 (6.8)	4 (6.7)	3 (4.9)	16 (4.0)	0 (5.7)	10 (12.8)	41
Declarative and Interrogative	6	11 (12.2)	19 (12.0)	8 (8.8)	8 (7.1)	3 (10.2)	24 (22.7)	73
Other Two-way Combinations	7-11	5 (12.8)	14 (12.6)	11 (9.3)	20 (7.5)	3 (10.8)	24 (24.0)	77
Three-way and Four-way Combinations	12-16	7 (12.7)	14 (12.5)	10 (9.2)	17 (7.4)	3 (10.6)	25 (23.7)	76
Total		131	129	95	77	110	245	787

$X^2 = 162.03$, $p < .001$

The most frequently occurring type of sentence pattern (for each objective type) was as follows:

Knowledge--Declarative

Analysis--Declarative

Synthesis--Declarative

Application--Other two-way combinations

Appreciation--None (no sentence)

The largest deviation from expected frequencies of sentence patterns (for illustrations of each objective type) was as follows:

Knowledge--6.7% more None
Analysis--6.8% fewer None
Synthesis--11.1% more Declarative
Application--31.9% fewer Declarative; 16.2% more Other two-way combinations
Appreciation--21.4% more None

As shown in Table 150, the pattern of deviations is different for illustrations of each objective type. For Application objectives there were fewer illustrations than expected with No sentences and with Declarative only, while there were more illustrations of all other types. For Appreciation objectives the pattern was the opposite.

TABLE 150. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Sentence Pattern		Objective Type Pattern					
		Total Agreement and Partial Agreement Among Judges					No Agreement 11
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	
None	1	+	-	-	-	+	-
Declarative	2	+	+	+	-	+	+
Interrogative, Imperative, Other	3-5	+	-	-	+	-	-
Declarative and Interrogative	6	0	+	0	0	-	+
Other Two-way Combinations	7-11	-	+	+	+	-	0
Three-way and Four-way Combinations	12-16	-	+	0	+	-	+

__Objective type pattern by non-sentence pattern.__ In relation to the instructional illustrations, the frequency of occurrence of non-sentence patterns was significantly associated with the pattern of objective types ($p < .001$), Table 151. (Several points on each scale were combined. Three cells remained with expected frequencies <5.) (See Tables 25 and 33 for descriptions of points on the scales.)

TABLE 151. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND VERBAL MODIFIER SCALE 5: NON-SENTENCE PATTERN

Non-sentence Pattern		Objective Type Pattern						Total
		Total Agreement and Partial Agreement Among Judges					No Agreement	
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11	
None	1	28 (32.6)	28 (32.1)	33 (23.7)	12 (19.2)	38 (27.4)	57 (61.0)	196
Titles	2	21 (21.8)	19 (21.5)	11 (15.8)	6 (12.8)	32 (18.3)	42 (40.8)	131
Labels	3	41 (36.6)	36 (36.1)	22 (26.6)	37 (21.5)	14 (30.7)	70 (68.5)	220
Titles and Labels	4, 5	31 (34.6)	38 (34.1)	27 (25.1)	22 (20.4)	25 (29.1)	65 (64.8)	208
Legends with Titles, Labels	6-8	10 (5.3)	8 (5.2)	2 (3.9)	0 (3.1)	1 (4.5)	11 (10.0)	32
Total		131	129	95	77	110	245	787

$\chi^2 = 63.24, p < .001$

The most frequently occurring non-sentence type (other than None) (for illustrations of each objective type) was as follows:

Knowledge--Labels	Application--Labels
Analysis--Titles and Labels	Appreciation--Titles
Synthesis--Titles and Labels	

The largest deviation from expected frequencies of non-sentence types (for illustrations of each objective type) was as follows:

Knowledge--3.5% fewer None; 3.5% more Legends with Titles, Labels
Analysis--3.2% fewer None; 3.1% more Titles and Labels
Synthesis--9.8% more None; 5.0% fewer Titles
Application--9.3% fewer None; 20.1% more Labels
Appreciation--12.5% more Titles; 15.3% fewer Labels

As shown in Table 152, a particular pattern of non-sentences was associated with illustrations of each objective type. The patterns for Application and Appreciation were essentially the opposite and were the source of the largest deviations, more labels for Application illustrations and fewer for Appreciation.

TABLE 152. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Non-sentence Pattern		Objective Type Pattern					
		Total Agreement and Partial Agreement Among Judges					No Agreement 11
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	
None	1	-	-	+	-	+	-
Titles	2	0	-	-	-	+	+
Labels	3	+	0	-	+	-	+
Titles and Labels	4, 5	-	+	+	+	-	0
Legends with Titles, Labels	6-8	+	+	-	-	-	0

Objective type pattern by sentence quantity. In relation to the instructional illustrations, the frequency of occurrence of sentences was significantly associated with the pattern of objective types (p $<.001$), Table 153. (Several points on each scale were combined. There remained four cells with expected frequencies <5.) (See Tables 25 and 30

TABLE 153. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND VERBAL MODIFIER SCALE 2: SENTENCE QUANTITY

Sentence Quantity		Objective Type Pattern						Total
		Total Agreement and Partial Agreement Among Judges					No Agreement 11	
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10		
None	1	45 (36.3)	28 (35.7)	16 (26.3)	11 (21.3)	53 (30.5)	65 (67.9)	218
One	2	23 (23.8)	21 (23.4)	19 (17.3)	11 (14.0)	19 (20.0)	50 (44.5)	143
Two	3	26 (24.5)	25 (24.1)	19 (17.7)	14 (14.4)	14 (20.5)	49 (45.8)	147
Three	4	11 (13.1)	18 (12.9)	8 (9.5)	8 (7.7)	10 (11.0)	24 (24.6)	79
Four	5	6 (8.2)	9 (8.0)	6 (5.9)	7 (4.8)	5 (6.8)	16 (15.3)	49
Five, Six	6	9 (9.2)	12 (9.0)	7 (6.6)	11 (5.4)	3 (7.7)	13 (17.1)	55
Seven to Ten	7	4 (5.8)	7 (5.7)	10 (4.2)	4 (3.4)	1 (4.9)	9 (10.9)	35
Eleven+	8-10	7 (10.2)	9 (10.0)	10 (7.4)	11 (6.0)	5 (8.5)	19 (19.0)	61
Total		131	129	95	77	110	245	787

$X^2 = 69.60$, p $<.001$

for descriptions of points on scales.)

The most frequently occurring sentence quantity (other than None) (for illustrations of each objective type) was as follows:

Knowledge--Two
Analysis--Two
Synthesis--One or Two
Application--Two
Appreciation--One

The largest deviation from expected frequencies of sentence quantities (for illustrations of each objective type) was as follows:

Knowledge--6.7% more None; 2.5% fewer Eleven + sentences
Analysis--6.0% fewer None; 4.0% more Three
Synthesis--10.9% fewer None; 6.1% more Seven to Ten
Application--13.4% fewer None; 7.3% more Five, Six
Appreciation--20.5% more None; 6.0% fewer Two

As shown in Table 154, the pattern of deviations revealed little tendency for either Knowledge or Appreciation illustrations to have more than the expected number of sentences, while for Application illustrations there were more of the larger quantities of sentences (Four to Six, Eleven+) than expected.

TABLE 154. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Sentence Quantity		Objective Type Pattern					
		Total Agreement and Partial Agreement Among Judges					No Agreement
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	11
None	1	+	-	-	-	+	-
One	2	0	-	+	-	0	+
Two	3	+	0	+	0	-	+
Three	4	-	+	-	0	0	0
Four	5	-	0	0	+	-	0
Five, Six	6	0	+	0	+	-	-
Seven to Ten	7	-	+	+	0	-	-
Eleven+	8-10	-	0	+	+	-	0

Objective type pattern by non-sentence quantity. In relation to the instructional illustrations, the frequency of occurrence of non-sentences was significantly associated with the pattern of objective types ($p < .001$), Table 155. (A number of points on one scale were combined. There remained six of 60 cells with expected frequencies <5.) (See Tables 25 and 32 for descriptions of points on the scales.)

TABLE 155. CHI-SQUARE FOR OBJECTIVE SCALE 2: TYPE PATTERN AND VERBAL MODIFIER SCALE 4: NON-SENTENCE QUANTITY

Non-sentence Quantity		Objective Type Pattern						Total
		Total Agreement and Partial Agreement Among Judges					No Agreement 11	
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10		
None	1	28 (32.6)	28 (32.1)	33 (23.7)	12 (19.2)	38 (27.4)	57 (61.0)	196
One	2	22 (23.3)	22 (22.9)	14 (16.9)	7 (13.7)	27 (19.6)	48 (43.6)	140
Two	3	15 (14.1)	12 (13.9)	10 (10.3)	7 (8.3)	18 (11.9)	23 (26.5)	85
Three, Four	4	17 (13.5)	12 (13.3)	7 (9.8)	13 (7.9)	14 (11.3)	18 (25.2)	81
Five, Six	5	10 (10.0)	13 (9.8)	5 (7.2)	6 (5.9)	4 (8.4)	22 (18.7)	60
Seven, Eight	6	8 (8.5)	2 (8.4)	6 (6.2)	11 (5.0)	4 (7.1)	20 (15.9)	51
Nine-Twelve	7	13 (9.3)	11 (9.2)	5 (6.8)	8 (5.5)	1 (7.8)	18 (17.4)	56
13-21	8	7 (8.7)	13 (8.5)	10 (6.3)	9 (5.1)	3 (7.3)	10 (16.2)	52
22-41	9	8 (5.7)	5 (5.6)	1 (4.1)	2 (3.3)	0 (4.8)	18 (10.6)	34
42+	10	3 (5.3)	11 (5.2)	4 (3.9)	2 (3.1)	1 (4.5)	11 (10.0	32
Total		131	129	95	77	110	245	787

$X^2 = 96.71$, $p < .001$

The most frequently occurring non-sentence quantity (other than None) (for illustrations of each objective type) was as follows:

Knowledge--One
Analysis--One
Synthesis--One
Application--Three, Four
Appreciation--One

The largest deviation from expected frequencies of non-sentences (for illustrations of each objective type) was as follows:

Knowledge--3.5% fewer None; 2.8% more None to Twelve
Analysis--4.9% fewer Seven, Eight; 4.4% more 42+
Synthesis--9.8% more None; 3.9% more 13-21
Application--9.3% fewer None; 8.7% fewer One
Appreciation--9.6% more None; 6.7% fewer One

As shown in Table 156, there were in general more illustrations having larger numbers of non-sentences which were associated with

TABLE 156. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Non-sentence Quantity		Objective Type Pattern					
		Total Agreement and Partial Agreement Among Judges					No Agreement 11
		Knowledge 1 & 6	Analysis 2 & 7	Synthesis 3 & 8	Application 4 & 9	Appreciation 5 & 10	
None	1	-	-	+	-	+	-
One	2	-	0	-	-	+	+
Two	3	0	-	0	-	+	-
Three, Four	4	+	-	-	+	+	-
Five, Six	5	0	+	-	0	-	+
Seven, Eight	6	0	-	0	+	-	+
Nine-Twelve	7	+	+	-	+	-	0
13-21	8	-	+	+	+	-	-
22-41	9	+	0	-	-	-	+
42+	10	-	+	0	-	-	0

Analysis and Application objectives, while there were more having smaller numbers of non-sentences which were associated with Appreciation objectives.

Part III

The third objective scale, Best Type, distributed illustrations across the five objective types according to a judge's choice of most appropriate or "best" from among the three objectives written by teachers for each illustration. All five of the verbal modifier scales were significantly associated with this scale, as shown in the analyses to follow.

Best objective type by verbal modifier type. The frequency of occurrence of types of verbal modifiers of illustrations was significantly associated with the educational objectives of the illustrations ($p < .001$), Table 157. (See Tables 26 and 29 for descriptions of points on the scales.)

The most frequently occurring verbal modifier for the illustrations was point 4, Both Sentence and Non-sentence, for all objective types.

The largest difference between actual and expected frequencies of verbal modifier types (for each objective type) was as follows:

Knowledge--4.1% more Non-sentences; 3.0% fewer None
Analysis--2.6% more Both; 2.4% fewer None
Synthesis--2.6% fewer Both; 2.5% more None
Application--27.2% more Both; 16.1% fewer Non-sentences
Appreciation--14.6% fewer Both; 7.9% more Non-sentences

TABLE 157. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND VERBAL MODIFIER SCALE 1: TYPE

Verbal Modifier Type		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
None	1	5 (11.1)	6 (10.6)	11 (7.5)	5 (5.1)	16 (8.6)	43
Sentence	2	41 (39.5)	40 (37.7)	30 (26.8)	8 (18.3)	34 (30.7)	153
Non-sentence	3	54 (45.7)	41 (43.6)	28 (31.0)	6 (21.1)	48 (35.5)	177
Both	4	103 (106.8)	107 (102.1)	69 (72.6)	75 (49.4)	60 (83.1)	414
Total		203	194	138	94	158	787

$X^2 = 57.30$, $p < .001$

Patterns of deviations, Table 158, from expected frequencies of verbal modifiers were for Application illustrations the approximate inverse of Appreciation illustrations. Each other objective type had its particular pair of more and less frequent verbal modifiers.

TABLE 158. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Verbal Modifier Type		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
None	1	-	-	+	0	+
Sentence	2	+	+	+	-	+
Non-sentence	3	+	-	-	-	+
Both	4	-	+	-	+	-

Best objective type by sentence pattern. With reference to the textbook illustrations, the frequency of occurrence of sentence patterns (verbal modifiers) was significantly associated with types of educational objectives ($p < .001$), Table 159. (Three of 35 cells had expected frequencies <5. Several points on one scale were combined.) (See Tables 26 and 31 for descriptions of points on scales.)

TABLE 159. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND VERBAL MODIFIER SCALE 3: SENTENCE PATTERN

Sentence Pattern		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
None	1	59 (56.2)	47 (53.7)	37 (38.2)	11 (26.0)	64 (43.8)	218
Declarative	2	95 (77.9)	74 (74.4)	55 (53.0)	8 (36.1)	70 (60.6)	302
Interrogative, Imperative or Other	3,4, 5	6 (10.6)	7 (10.1)	5 (7.2)	19 (4.9)	4 (8.2)	41
Declarative and Interrogative	6	17 (18.8)	22 (18.0)	13 (12.8)	12 (8.7)	9 (14.7)	73
Declarative and Imperative	7	13 (13.2)	15 (12.6)	4 (8.9)	16 (6.1)	3 (10.2)	51
All Other Paired Types	8-11	2 (6.7)	7 (6.4)	9 (4.6)	6 (3.1)	2 (5.2)	26
Three or More Types	12-16	11 (19.6)	22 (18.7)	15 (13.3)	22 (9.1)	6 (15.3)	76
Total		203	194	138	94	158	787

$X^2 = 162.44$, $p < .001$

The most frequently occurring type of sentence pattern was Declarative for all objective types except Application, for which the most frequent was Three or More Types.

The largest deviation from expected frequencies of sentence patterns (for illustrations of each objective type) was as follows:

Knowledge--8.4% more Declarative sentences; 4.3% fewer Three or More Types

Analysis--2.0% more combined Declarative and Interrogative; 3.5% fewer None

Synthesis--3.6% fewer combined Declarative and Imperative; 3.2% more All Other Paired Types

Application--29.9% fewer Declarative; 16.0% fewer None

Appreciation--12.8% more None; 5.9% more Declarative; 5.9% fewer Three or More Types

The pattern of deviations of sentence patterns from expected frequencies, Table 160, varied according to the objective of the illustration as follows:

TABLE 160. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Sentence Pattern		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
None	1	+	-	-	-	+
Declarative	2	+	0	+	-	+
Interrogative, Imperative or Other	3,4, 5	-	-	-	+	-
Declarative and Interrogative	6	-	+	0	+	-
Declarative and Imperative	7	0	+	-	+	-
All Other Paired Types	8-11	-	0	+	+	-
Three or More Types	12-16	-	+	+	+	-

Knowledge and Appreciation--more No-sentences and More Declarative but less of all other types and combinations.

Application--the opposite of Knowledge and Appreciation.

Analysis and Synthesis--generally more combinations of sentence types.

Best objective type by non-sentence pattern. With reference to the textbook illustrations, the frequency of occurrence of non-sentence patterns was significantly associated with educational objective types ($p < .001$), Table 161. (One cell had expected frequencies <5. Several points on one scale were combined.) (See Tables 26 and 33 for descriptions of points on the scales.)

TABLE 161. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND VERBAL MODIFIER SCALE 5: NON-SENTENCE PATTERN

Non-sentence Pattern		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
None	1	46 (50.6)	46 (48.3)	41 (34.4)	13 (23.4)	50 (39.3)	196
Titles	2	30 (33.8)	28 (32.3)	21 (23.0)	6 (15.6)	46 (26.3)	131
Labels	3	60 (56.7)	52 (54.2)	33 (38.6)	47 (26.3)	28 (44.2)	220
Titles and Labels	4,5	56 (53.7)	56 (51.3)	38 (36.5)	26 (24.8)	32 (41.8)	208
Legends with Titles, Labels	6-8	11 (8.3)	12 (7.9)	5 (5.6)	2 (3.8)	2 (6.4)	32
Total		203	194	138	94	158	787

$X^2 = 64.5, p < .001$

The most frequently occurring type of non-sentence pattern associated with each objective type was as follows:

Knowledge--Labels

Analysis--combined Titles and Labels

Synthesis--None

Application--Labels

Appreciation--None

The largest deviation from expected frequencies of non-sentence patterns (for illustrations of each objective type) was as follows:

Knowledge--2.2% fewer with None

Analysis--2.5% more Titles and Labels combined

Synthesis--4.8% more with None; 4.1% fewer Labels

Application--22.0% more Labels; 11.1% fewer None

Appreciation--12.5% more Titles; 10.3% fewer Labels

The pattern of deviations of non-sentence patterns from expected frequencies, Table 162, varied according to the subject matter of the illustrations as follows:

TABLE 162. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Non-sentence Pattern		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
None	1	-	-	+	-	+
Titles	2	-	-	-	-	+
Labels	3	+	-	-	+	-
Titles and Labels	4,5	+	+	+	+	-
Legends with Titles, Labels	6-8	+	+	0	-	-

Knowledge--more Labels, alone and in combination

Appreciation--the opposite of Knowledge, more Titles and more with None

Analysis--like Knowledge except fewer Labels alone

Application--like Knowledge except fewer combinations with Legends

Best objective type by sentence quantity. With reference to the instructional illustrations, the frequency of occurrence of sentences was significantly associated with the types of educational objectives ($p < .001$), Table 163. (One cell had an expected frequency < 5.) (See Tables 26 and 30 for descriptions of points on the scales.)

TABLE 163. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND VERBAL MODIFIER SCALE 2: SENTENCE QUANTITY

Sentence Quantity		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
None	1	59 (56.2)	47 (53.7)	38 (38.2)	11 (26.0)	63 (43.8)	218
One	2	41 (36.9)	30 (35.3)	25 (25.1)	12 (17.1)	35 (28.7)	143
Two	3	39 (37.9)	41 (36.2)	25 (25.8)	17 (17.6)	25 (29.5)	147
Three	4	17 (20.4)	28 (19.5)	9 (13.9)	13 (9.4)	12 (15.9)	79
Four	5	15 (12.6)	11 (12.1)	7 (8.6)	10 (5.9)	6 (9.8)	49
Five, Six	6	14 (14.2)	13 (13.6)	11 (9.6)	12 (6.6)	5 (11.0)	55
7-10	7	6 (9.0)	9 (8.6)	10 (6.1)	6 (4.2)	4 (7.0)	35
11+	8-10	12 (15.7)	15 (15.0)	13 (10.7)	13 (7.3)	8 (12.2)	61
Total		203	194	138	94	158	787

$X^2 = 58.09$, $p < .001$

With the exception of point 1 (None), the most frequently occurring sentence quantity (for illustrations of each objective type) was as follows:

Knowledge--One	Application--Two
Analysis--Two	Appreciation--One
Synthesis--One or Two	

The largest deviation from expected frequencies of sentences (for illustrations of each objective type) was as follows:

Knowledge--2.0% more One	Application--16.0% fewer None; 6.0% more Eleven+
Analysis--4.4% more Three	
Synthesis--3.5% fewer Three	Appreciation--12.2% more None; 4.0% more One

The pattern of deviations, Table 164, of sentence quantity varied according to the objective type of the illustration as follows:

Knowledge--more of small quantities, None to Four

Analysis--more of small quantities, Two and Three

Synthesis--more of large quantities, Five to 11+

Application and Appreciation--opposite patterns, more Three to 11+ and more None and One

TABLE 164. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Sentence Quantity		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
None	1	+	-	0	-	+
One	2	+	-	0	-	+
Two	3	+	+	0	0	-
Three	4	-	+	-	+	-
Four	5	+	-	-	+	-
Five, Six	6	0	0	+	+	-
7-10	7	-	0	+	+	-
11+	8-10	-	0	+	+	-

Best objective type by non-sentence quantity. With regard to the textbook illustrations, the frequency of occurrence of non-sentences was significantly associated with the types of educational objectives ($p < .001$), Table 165. (Two cells had expected frequencies < 5.) (See Tables 26 and 32 for descriptions of points on the scales.)

TABLE 165. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND VERBAL MODIFIER SCALE 4: NON-SENTENCE QUANTITY

Non-sentence Quantity		Best Objective Type					Total
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5	
None	1	46 (50.6)	46 (48.3)	41 (34.4)	13 (23.4)	50 (39.3)	196
One	2	34 (36.1)	31 (34.5)	24 (24.5)	9 (16.7)	42 (28.1)	140
Two	3	18 (21.9)	19 (21.0)	16 (14.9)	9 (10.2)	23 (17.1)	85
Three, Four	4	21 (20.9)	20 (20.0)	11 (14.2)	14 (9.7)	15 (16.3)	81
Five, Six	5	19 (15.5)	16 (14.8)	10 (10.5)	9 (7.2)	6 (12.0)	60
Seven, Eight	6	11 (13.2)	7 (12.6)	11 (8.9)	14 (6.1)	8 (10.2)	51
9-12	7	19 (14.4)	17 (13.8)	5 (9.8)	10 (6.7)	5 (11.2)	56
13-21	8	11 (13.4)	18 (12.8)	12 (9.1)	9 (6.2)	2 (10.4)	52
22-41	9	15 (8.8)	10 (8.4)	4 (6.0)	4 (4.1)	1 (6.8)	34
42+	10	9 (8.3)	10 (7.9)	4 (5.6)	3 (3.8)	6 (6.4)	32
Total		203	194	138	94	158	787

$X^2 = 77.45$, $p < .001$

With the exception of point 1 (None), the most frequently occurring non-sentence quantity (for illustrations of each objective type) was as follows:

Knowledge--One
Analysis--One
Synthesis--One
Application--Three, Four; also Seven, Eight
Appreciation--One

The largest deviation from expected frequencies of non-sentences (for illustrations of each objective type) was as follows:

Knowledge--3.1% more 22-41
Analysis--2.9% less Seven, Eight
Synthesis--3.5% less 9-12; 4.8% more None
Application--8.4% more Seven, Eight; 10.9% less None
Appreciation--8.8% more One; 6.7% more None

The most consistent patterns of deviation, Table 166, were for

TABLE 166. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Non-sentence Quantity		Best Objective Type				
		Knowledge 1	Analysis 2	Synthesis 3	Application 4	Appreciation 5
None	1	-	-	+	-	+
One	2	-	-	0	-	+
Two	3	-	-	+	-	+
Three, Four	4	0	0	-	+	-
Five, Six	5	+	+	0	+	-
Seven, Eight	6	-	-	+	+	-
9-12	7	+	+	-	+	-
13-21	8	-	+	+	+	-
22-41	9	+	+	-	0	-
42+	10	0	+	-	0	0

Analysis illustrations which had more large quantities of non-sentences (9-42+); for Application illustrations, more medium amounts (3-21); and for Appreciation objectives, more small amounts (None to Two).

Part IV

The fourth objective type scale, Level Agreement, measured the amount of agreement among three teachers as to the level of difficulty (degree of learner involvement) in meeting each objective. The five verbal modifier scales were non-significantly associated with this scale as follows:

Verbal Modifier Type--Chi-Square--5.10 at 6 df
Sentence Pattern--Chi-Square--16.45 at 12 df
Non-sentence Pattern--Chi-Square--9.43 at 8 df
Sentence Quantity--Chi-Square--6.06 at 14 df
Non-sentence Quantity--Chi-Square--16.52 at 18 df

Part V

The fifth objective type scale, Best Level, measured on a 5-point scale the level of difficulty (degree of learner involvement) in meeting each objective. All five verbal modifier scales were significantly associated with this scale. (For these five analyses, points 1 and 2 were combined and points 4 and 5 were combined to eliminate expected frequencies < 2.)

Best objective level by verbal modifier type. The frequency of occurrence of the types of verbal modifiers of the illustrations was significantly associated with the levels of the objectives for the illustrations ($p < .001$), Table 167. (Several points on one scale were combined.) (See Tables 28 and 29 for descriptions of the points on the scales.)

TABLE 167. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND VERBAL MODIFIER SCALE 1: TYPE

Verbal Modifier Type		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
None	1	25(16.0)	16(17.3)	2(9.7)	43
Sentence	2	69(57.0)	59(61.6)	25(34.4)	153
Non-sentence	3	88(65.9)	59(71.3)	30(39.8)	177
Both	4	111(154.1)	183(166.8)	120(93.1)	414
Total		293	317	177	787

$X^2 = 49.83$, $p < .001$

The combination of Both Sentences and Non-sentences was the most frequent type of verbal modifier for illustrations of all objective levels.

The largest deviation of verbal modifier types from expected frequencies (for illustrations at each objective level) was as follows:

Limited--14.7% fewer Both; 7.5% more Non-sentences
Average--5.1% more Both; 3.9% fewer Non-sentences
Extensive--15.2% more Both; 5.6% fewer Non-sentences

Associated with lower level objectives (1-2), Table 168, was a greater number than expected of illustrations with no verbal modifiers or with Sentences or with Non-sentences, while associated with average or higher level objectives (3-5) were illustrations with more Both Sentences and Non-sentences than expected.

TABLE 168. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Verbal Modifier Type		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
None	1	+	-	-
Sentence	2	+	-	-
Non-sentence	3	+	-	-
Both	4	-	+	+

Best objective level by sentence pattern. In relation to the instructional illustrations, the frequency of occurrence of sentence patterns was significantly associated with the levels of the objectives ($p < .001$), Table 169. (Several points on one scale were combined.) (See Tables 28 and 31 for descriptions of points on the scales.)

TABLE 169. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND VERBAL MODIFIER SCALE 3: SENTENCE PATTERN

Sentence Pattern		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
None	1	113(81.2)	73(87.8)	32(49.0)	218
Declarative	2	129(112.4)	124(121.6)	49(67.9)	302
Interrogative, Imperative, or Other	3-5	15(15.3)	14(16.5)	12(9.2)	41
Declarative and Interrogative	6	15(27.2)	37(29.4)	21(16.4)	73
Other Two-way Combinations	7-11	12(28.7)	35(31.0)	30(17.3)	77
Three-way and Four-way Combinations	12-16	9(28.3)	34(30.6)	33(17.1)	76
Total		293	317	177	787

$X^2 = 86.40$, $p < .001$

The Declarative sentence was the most frequently occurring for illustrations at each objective level.

The largest deviation from expected frequencies of sentence patterns (for illustrations at each objective level) was as follows:

Limited--10.9% more None; 6.6% fewer Three- and Four-way Combinations

Average--4.7% fewer None

Extensive--10.7% fewer Declarative; 9.6% fewer None

As shown in Table 170, there were more None and Declarative sentences than expected with illustrations having lower level (1 & 2) objectives, while there were more of all other sentence patterns than expected with illustrations having higher level (4 & 5) objectives.

TABLE 170. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Sentence Pattern		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
None	1	+	-	-
Declarative	2	+	+	-
Interrogative, Imperative, or Other	3-5	0	-	+
Declarative and Interrogative	6	-	+	+
Other Two-way Combinations	7-11	-	+	+
Three-way and Four-way Combinations	12-16	-	+	+

Best objective level by non-sentence pattern. With reference to the instructional illustrations, the frequency of occurrence of non-sentence patterns was significantly associated with the levels of the educational objectives ($p < .001$), Table 171. (Several points on each scale were combined.) (See Tables 28 and 33 for descriptions of points on the scales.)

TABLE 171. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND VERBAL MODIFIER SCALE 5: NON-SENTENCE PATTERN

Non-sentence Pattern		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
None	1	94(73.0)	75(78.9)	27(44.1)	196
Titles	2	69(48.8)	46(52.8)	16(29.5)	131
Labels	3	66(81.9)	89(88.6)	65(49.5)	220
Titles and Labels	4,5	57(77.4)	90(83.8)	61(46.8)	208
Legends, with Titles, Labels	6-8	7(11.9)	17(12.9)	8(7.2)	32
Total		293	317	177	787

$X^2 = 49.85$, $p < .001$

The most frequently occurring type of non-sentence pattern (omitting None) (for illustrations at each objective level) was as follows:

Limited--Titles
Average--combined Titles and Labels
Extensive--Labels

The largest deviation from expected frequencies of non-sentence patterns (for illustrations at each level of objective) was as follows:

Limited--7.2% more with None; 6.9% more Titles; 6.9% fewer Titles and Labels

Average--2.1% fewer Titles

Extensive--9.6% fewer with None; 8.7% more Labels; 8.1% more Titles and Labels

The pattern of deviations, Table 172, shows that illustrations with lower level objectives (1 & 2) have more Titles alone or more with None, while illustrations with average and higher level objectives (3-5) have more Labels alone and in combinations with Titles and Legends.

TABLE 172. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Non-sentence Pattern		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
None	1	+	-	-
Titles	2	+	-	-
Labels	3	-	0	+
Titles and Labels	4,5	-	+	+
Legends, with Titles, Labels	6-8	-	+	0

Best objective level by sentence quantity. In relation to the instructional illustrations, the frequency of occurrence of sentences was significantly associated with the levels of the objectives ($p < .001$), Table 173. (Several points on each scale were combined.) (See Tables 28 and 30 for descriptions of points on the scales.)

The most frequently occurring sentence quantity (except None) for illustrations at each objective level was as follows:

Limited--One sentence
Average--Two sentences
Extensive--Eleven+ sentences

The largest deviation from expected frequencies of sentence quantities (for illustrations at each objective level) was as follows:

TABLE 173. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND VERBAL MODIFIER SCALE 2: SENTENCE QUANTITY

Sentence Quantity		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
None	1	113(81.2)	73(87.8)	32(49.0)	218
One	2	68(53.2)	48(57.6)	27(32.2)	143
Two	3	52(54.7)	69(59.2)	26(33.1)	147
Three	4	27(29.4)	39(31.8)	13(17.8)	79
Four	5	15(18.2)	23(19.7)	11(11.0)	49
Five, Six	6	10(20.5)	28(22.2)	17(12.4)	55
7-10	7	2(13.0)	16(14.1)	17(7.9)	35
11+	8-10	6(22.7)	21(24.6)	34(13.7)	61
Total		293	317	177	787

$X^2 = 106.50,\ p < .001$

Limited--10.9% more None; 5.0% more One; 5.8% fewer Eleven+

Average--4.7% fewer None; 3.1% fewer One

Extensive--9.6% fewer None; 5.2% more Seven to Ten; 11.4% more Eleven+

As shown in Table 174, there were at the Limited objective level more illustrations than expected with 0 to 1 sentence, at the Average level more "middle" quantities of sentences (2-10), and at the Extensive level more "large" quantities of sentences (5-11+).

TABLE 174. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Sentence Quantity		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
None	1	+	-	-
One	2	+	-	-
Two	3	-	+	-
Three	4	-	+	-
Four	5	-	+	0
Five, Six	6	-	+	+
Seven to Ten	7	-	+	+
Eleven+	8-10	-	-	+

Best objective level by non-sentence quantity. In relation to the instructional illustrations, the frequency of occurrence of non-sentences was significantly associated with levels of the objectives ($p < .001$), Table 175. (Several points on one scale were combined.) (See Tables 28 and 32 for descriptions of points on the scales.)

The most frequently occurring quantity of non-sentences (other than None) (for illustrations at each level of objective) was as follows:

Limited--One non-sentence
Average--One non-sentence
Extensive--Seven to Twelve non-sentences

The largest deviation from expected frequencies of non-sentences (for illustrations at each objective level) was as follows:

Limited--7.2% more None; 7.1% more One; 4.0% fewer 9-12
Average--1.4% fewer One; 1.4% more Three, Four
Extensive--9.6% fewer None; 9.3% fewer One; 5.5% more 42+

TABLE 175. CHI-SQUARE FOR OBJECTIVE SCALE 5: BEST LEVEL AND VERBAL MODIFIER SCALE 4: NON-SENTENCE QUANTITY

Non-sentence Quantity		Best Objective Level			Total
		Limited 1 & 2	Average 3	Extensive 4 & 5	
None	1	94(73.0)	75(78.9)	27(44.1)	196
One	2	73(52.1)	52(56.4)	15(31.5)	140
Two	3	36(31.6)	37(34.2)	12(19.1)	85
Three, Four	4	26(30.2)	37(32.6)	18(18.2)	81
Five, Six	5	26(22.3)	20(24.2)	14(13.5)	60
Seven, Eight	6	8(19.0)	22(20.5)	21(11.5)	51
9-12	7	9(20.8)	26(22.6)	21(12.6)	56
13-21	8	8(19.4)	24(20.9)	20(11.7)	52
22-41	9	7(12.7)	15(13.7)	12(7.6)	34
42+	10	6(11.9)	9(12.9)	17(7.2)	32
Total		293	317	177	787

$X^2 = 99.03$, $p < .001$

As shown in Table 176, there were at the Limited level more illustrations than expected with 0-2 Non-sentences, while at the Extensive level there were more illustrations than expected with 7-42+ Non-sentences.

Summary. Of the 25 Chi-Square analyses between objective type scales and verbal modifier type scales, 16 showed statistically significant associations. The nine non-significant results were related to two scales, Objective Type Agreement and Objective Level Agreement. Thus, there was little demonstrated relationship between the amount of agreement by teacher-judges and the verbal modifiers of the illustrations they judged.

TABLE 176. DIRECTION OF DEVIATIONS OF ACTUAL FROM EXPECTED FREQUENCIES

Non-sentence Quantity		Best Objective Level		
		Limited 1 & 2	Average 3	Extensive 4 & 5
None	1	+	-	-
One	2	+	-	-
Two	3	+	+	-
Three, Four	4	-	+	0
Five, Six	5	+	-	0
Seven, Eight	6	-	+	+
9-12	7	-	+	+
13-21	8	-	+	+
22-41	9	-	+	+
42+	10	-	-	+

The two estimates of the most appropriate objectives for the illustrations (Objective Type Pattern and Best Objective Type) were in agreement 15 of 25 times as to the largest deviation from expected frequencies of verbal modifier types. On both objective type scales illustrations with Application objectives were in most frequent contrast to those with Appreciation objectives.

It was of interest to note whether there was any tendency for the deviations of actual from expected frequencies of verbal modifier types to form patterns, i.e., for the deviations for one objective type to be alike or unlike those for other objective types. The most frequently occurring pattern (31% of the cases) was one in which Knowledge and Appreciation deviations were in one direction, while Analysis, Synthesis and Application deviations were in the other. For example, if there were more of one type of verbal modifier associated with Knowledge and Appreciation illustrations than expected, there were less of that verbal modifier associated with Analysis, Synthesis, and Application illustrations. The next most frequently occurring pattern (13%) was one in which Knowledge, Analysis, and Application deviations were in one direction and Synthesis and Appreciation deviations were in the other.

The Coefficients of Contingency for smallest and largest X^2 in this section are as follows:

C = .21 for Objective Type Agreement by Non-sentence Quantity

C = .41 for Best Objective Type by Sentence Pattern.

The relationship between verbal modifiers and objective levels was pronounced. The illustrations with higher level objectives, for example, had more than expected of both types of verbal modifiers together (sentences and non-sentences) and less of each type alone. Of the illustrations having sentence modifiers there were more at lower levels than expected with declarative sentences, and more at higher levels with Interrogative, Imperative, and all combinations of two, three, or four sentence types. Of the illustrations having non-sentence modifiers, more at low levels than expected had titles only, while more at high levels had labels only or a combination of both. For both sentences and non-sentences, more small quantities than expected were associated with illustrations at low objective levels and more large quantities than expected were associated with illustrations at high objective levels. Thus, the level of difficulty of the objective assigned each illustration was positively related to the number of types of verbal modifiers and to the overall number of verbal modifiers associated with the illustrations.

There were three possible patterns of association between verbal modifiers and objective levels. Of these, one pattern predominated (70% of the cases). This pattern was one in which deviations for Limited Level objectives were in one direction and those for Average and High Level objectives were in the other.

It would be possible from the data to describe the most frequently occurring or most probable verbal modifiers for illustrations of each objective type. For example, the "typical" illustration with a Knowledge objective would be more likely to contain both sentence and non-sentence types than it would either alone, if it contained sentences they would be declarative in type and one in number, if it contained non-sentences they would be labels and would be one in number. Table 177 gives comparable information about the most frequently occurring point on each verbal modifier scale for each of the other types of objectives. For example, for Verbal Modifier Scale 5: Non-sentence pattern, point 5 (Titles and Labels) was most frequent or probable for Analysis illustrations. One could say that 29% of Analysis illustrations had both titles and labels, or that .29 was the best estimate of the probability that a particular Analysis illustration would have both titles and labels, and that no other non-sentence verbal modifier types were more probable.

The data in Table 177 do not necessarily indicate the sources of the statistical differences found. Note also that while the point number for each verbal modifier scale is given, the name or description of it

TABLE 177. MOST FREQUENTLY OCCURRING POINT ON VERBAL MODIFIER TYPE SCALES FOR ILLUSTRATIONS OF EACH OBJECTIVE TYPE AND PERCENTAGE OF ILLUSTRATIONS OF EACH OBJECTIVE TYPE THAT WERE AT THAT POINT

Verbal Modifier Type	Best Objective Type									
	Knowledge		Analysis		Synthesis		Application		Appreciation	
	Point	Per cent	Point	Per cent	Point	Per cent	Point	Per cent	Point	Per cent
1. Type	4, Both types	51	4, Both types	55	4, Both types	50	4, Both types	80	4, Both types	38
2. Sentence Quantity	2, One	20	3, Two	21	2,3 One or Two	18	3, Two	18	2, One	22
3. Sentence Pattern	2, Declarative	47	2, Declarative	38	2, Declarative	40	12-16, Three or more types	23	2, Declarative	44
4, Nonsentence Quantity	2, One	17	2, One	16	2, One	17	4 or 6 Three & Four, or Seven & Eight	15	2, One	27
5. Nonsentence Pattern	3, Labels	30	5, Titles & Labels	29	1, None	30	3, Labels	50	1, None	32

may be so abbreviated as to lead to erroneous interpretation. See Chapter VI for more complete descriptions.

It would also be possible from these data to describe the most frequently occurring or probable type of verbal modifier associated with illustrations at each level of objective. For example, the "typical" verbal modifiers for illustrations at extensive objective levels (high) would have both sentence and non-sentence modifiers, the sentences being declarative in type and eleven+ in number, and the non-sentences being labels in type and seven to twelve in number.

Table 178 gives comparable information about the most frequently

TABLE 178. MOST FREQUENTLY OCCURRING POINT ON VERBAL MODIFIER TYPE SCALES FOR ILLUSTRATIONS OF EACH OBJECTIVE LEVEL AND PERCENTAGE OF *ILLUSTRATIONS OF EACH OBJECTIVE LEVEL THAT WERE AT THAT POINT*

Verbal Modifier Type	Best Objective Level					
	Limited		Average		Extensive	
	Point	Per cent	Point	Per cent	Point	Per cent
1. Type	4, Both sentence and non-sentence	38	4, Both sentence and non-sentence	58	4, Both sentence and non-sentence	68
2. Sentence Quantity	2, One	23	3, Two	22	8-10, Eleven+	19
3. Sentence Pattern	2, Declarative	44	2, Declarative	39	2, Declarative	28
4. Non-sentence Quantity	2, One	25	2, One	16	6 & 7, Seven to twelve	24
5. Non-sentence Pattern	2, Titles	24	4,5, Titles and Labels	28	3, Labels	37

occurring point on each verbal modifier scale for each of the other levels of objectives. Note, for example, that while for the Limited Level the most frequently occurring type of verbal modifier (scale 1) is 4, Both sentences and non-sentences, the percentages associated with its occurrence increase as the level of the objective increases. Similarly, Verbal Modifier Scale 3: Sentence Pattern indicates that the declarative sentence is more characteristic (higher percentage) of limited objective levels than of extensive. (For a more accurate description of the point numbers given see Chapter VI.)

In sum the 16 analyses reveal systematic differences in the verbal modifiers of illustrations in relation to the type and level of the objectives for those illustrations. In a way these data constitute "hypotheses" stating that the learning necessary to the meeting of each type and level of objective can be optimized by illustrations having certain types of verbal modifiers. These "hypotheses" suggest directions for experimental research.

CHAPTER VIII

DISCUSSION

The summaries for the five sections of the Results Chapter (pp. 135, 153, 165, 231, 268) included preliminary discussions of the results. What follows will be more selective and will depart further from the data.

Subject matter by objective type. The significant associations between the subject matter of instructional illustrations and the type of objective assigned them can be interpreted variously. To the extent that certain subject matters may be characterized by a predominance of certain types of objectives over other types, it was to be expected that stimuli intended to teach such subjects would be assigned objectives in comparable proportions. However, some of the objective pattern data do not seem consistent with the subject matter. For example, the most frequently occurring objectives for science illustrations were Knowledge (recall of facts) and Appreciation, and there were fewer Analysis objectives than expected--evidence which does not seem consistent with either the subject of science or the curriculum trends toward inquiry in science. History illustrations came closer to what one might expect of a pure science emphasis, viz. more Analysis objectives and less Application objectives than expected.

It might also be the case that illustrations tend to be more suitable for some objective types than for others. The data provide no substantial evidence regarding this possibility. It might have been expected (on the basis of publishers' comments) that the illustrations would be assigned more affective objectives than cognitive. The data, however, indicate that only 20.1% of the sample had affective objectives (Appreciation), while 79.9% had cognitive objectives (Knowledge, Analysis, Synthesis, and Application). The two most frequently occurring types of objectives were Knowledge (25.8%) and Analysis (24.7%), while the least frequent was Application (11.9%) over half of which were for mathematics illustrations. There were more Application objectives than expected for mathematics (a fact that may not please the "new math" proponents) which can be accounted for by the frequency of illustrated mathematical problems requiring the application of known rules. English illustrations were predictably heavy on Appreciation objectives, there being a limited number of other alternatives because of the less than obvious relationship between grammer and pictorial elements. Unexpected was the finding that only 2% of the English illustrations were assigned Synthesis objectives. Although synthesis activities such as composition and creative writing would be confined to the verbal mode, the object or event described could have been suggested by an illustration. It may be that messages which can be adequately pictured, instead of being a stimulus to verbalization, may remove the incentive to verbalize.

The pattern of deviations of objective types in relation to subject matters yielded some additional surprises. The subjects commonly related in the curriculum, English with history and mathematics with science, had opposite patterns of deviations in 9 of 11 cases. For example, where English illustrations had fewer Knowledge objectives, history had more; and where mathematics illustrations had less Synthesis objectives, science had more. Contrary to expectations, the deviations of English and science illustrations were in the same direction with regard to objective types in 8 of 11 cases. Perhaps the common curriculum groupings are ones of opposites, at least as far as objectives for illustrations are concerned.

The level of difficulty (degree of student involvement), assigned to each illustration and its objective by the teacher-judge who wrote the objective, yielded an estimate of the level of instruction assigned to illustrations within each subject matter. The science and history teachers assigned more limited or low level objectives to their illustrations than expected, while the English and mathematics teachers assigned more extensive or high level objectives to their illustrations. There is no apparent explanation for this pattern. However, the largest deviation (9.6% more Extensive Level than expected) was for mathematics. This may be because in mathematics many illustrations were an integral part of problems and exercises while very few illustrations in other subject areas were used to pose problems.

In sum, the objective types assigned illustrations appear in part to be predictably compatible with the subject matter and in part non-obvious and incompatible. Yet to be established by experimental research is the relative efficacy of pictorial stimuli for each type of objective in each subject matter. Do Appreciation illustrations, such as in English textbooks, influence the learner's attitude toward the book or the subject? Are illustrations (perhaps non-objective art) appropriate stimuli for creative writing? Can illustrations be designed that will facilitate critical observation and arouse questions and hypotheses which lead to scientific inquiry?

Subject matter by physical type. It was anticipated that the physical type of an illustration would be significantly associated with the subject matter type. Prior to this study, the specifics of this association were lacking. For example, one might well have assumed that mathematics illustrations would tend to be smaller in size than those for history. For some physical characteristics, there were, nonetheless, some unexpected findings. For example, there were more color illustrations (Mono-chromatic and Duo-chromatic) than expected for mathematics. Why? Is color relevant to the abstract figural, spatial and quantitative concepts of mathematics? It seems appropriate, on the other hand, that there were no full-color illustrations in the mathematics sample.

It might be anticipated that the disciplines considered more formal in structure (English and mathematics) would be illustrated more abstractly than history and science. This anticipation was partially confirmed in that no mathematics illustrations and only 4% of the English illustrations were in the more realistic photographic medium. Most of the photographs were in science and history; however, even there they were second in frequency of occurrence to artistic media.

It seemed probable that a disproportionately large number of illustrations in science and history would contain both pictorial and verbal elements (labelled parts of scientific objects and events and labelled maps and time lines in history). Such was not the case. Most illustrations in both science and history contained pictorial elements only, i.e., no verbal elements within the pictorial unit. However, many had verbal elements in adjacent captions.

The most frequently occurring pattern of deviations was one in which English and mathematics had illustrations with similar physical characteristics and in contrast to those for history and science. For example, for a particular point on a physical type scale such as Full-achromatic there were fewer English and mathematics illustrations but more history and science than expected. This pattern or its inverse (more English and mathematics but less history and science) occurred in 36% of the cases. To the extent that illustrations might be expected to reflect the basic characteristics of the kinds of knowledge they represent, the grouping of English and mathematics illustrations is consistent with the grouping of those subjects as "Symbolics." However, the grouping of science and history illustrations is not consistent with their respective and distinct empiric and synoptic "ways of knowing." Both science and history do deal with concrete objects and events and thus might conceivably be illustrated comparably.

The next most frequently occurring pattern of deviations (21% of the cases) puts mathematics in a class by itself. For example, more Diagrammatic style illustrations occurred in mathematics than expected while less occurred in the other three subjects. This finding seems consistent with the Comtian ordering of the disciplines with mathematics as the "science" underlying all others, being basic to but separate from the others.

Thus, while some associations of physical type and subject matter were anticipated at the outset, and most seemed plausible in retrospect, a few were neither. Further, although most associations that were found seem valid as indicators of modern textbook design practices, few were demonstrably the most efficient match of physical type with subject matter type for instructional purposes.

Subject matter by verbal modifier type. Only 5.5% of the illustrations in the sample had no verbal modifiers, as defined herein, while 52.6% had both sentence and non-sentence types of verbal modifiers. It is apparent that illustrations, designed for instructional purposes, generally consisted of both pictorial and verbal elements.

The types of verbal modifiers were found to be disproportionately distributed across subject matters. One of the surprises for this investigator was that English was the only subject for which there were more illustrations than expected without any verbal modifiers, i.e., no captions, labels, titles, or legends. Perhaps illustrations in English books are frequently conceived as basically incompatible with or at least irrelevant to the verbal subject matter. The 17.9% of English illustrations that had no verbal modifiers (over three times the percentage for any other subject) gives evidence of a lack of synthesis of the pictorial and verbal. It does seem appropriate that where sentences were used with English illustrations the variety in type of sentence employed was greater than for history or science illustrations.

Unsurprisingly, the declarative sentence predominated, except for mathematics illustrations for which a combination of three or more types of sentences was most frequent. Mathematics illustrations were unique in having more of all the larger quantities of sentences, 4 to 11+, and less of the smaller quantities than expected. The large number of sentence modifiers was attributable to mathematics illustrations being frequently in the form of problems that included a geometric figure together with several accompanying sentences.

The fact that 38% of the illustrations were accompanied by one or more declarative sentences and that another 26% were accompanied by declarative in combination with one or more other types of sentences would indicate a strong tendency toward an information presentation role. To the extent that the verbal modifiers prescribe what the learner is to do with regard to the illustrations, it would seem that a passive acceptance of presented information was expected in most cases. In only 5% of the cases was an illustration accompanied by an interrogative or imperative sentence. There were, however, more cases (23%) in which declarative sentences were combined with interrogative, imperative, or both, which suggests that to this degree the learner was to become involved in searching the illustrations for answers to questions or was to follow instructions with regard to the illustrations. In such cases learners may become engaged in active transactions with the illustrations and the role of the illustrations would certainly exceed that observed by Hickey who considered them to be only "supplements to already complete verbal or symbolic-numeric presentations." (6)

Labels were the most frequently occurring non-sentence modifiers for all subjects except history, for which the most frequent was titles. By definition in this study, labels referred to part of an illustration while titles referred to the whole. Consequently, for all subject matters except history it might be inferred that illustrations with non-sentence modifiers were used more often to teach concepts involving the (labelled) parts of pictured objects or events, while history illustrations were used more often for concepts involving the (titled) whole of an object or event.

Objective type by physical type. Throughout the many significant associations between objective type and physical type runs a consistent contrast between Application and Appreciation objectives. For example, fewer Application illustrations than expected (23.2% fewer) had pictorial elements only, while more Appreciation illustrations than expected (22.5% more) had pictorial elements only. Unanticipated was the finding that, while Mono- and Duo-chromatic illustrations were the most frequently occurring for all other objective types, the Non-chromatic was most frequent for Appreciation objectives. The Full-chromatic illustrations, which might have been expected to predominate for Appreciation objectives, were found instead more frequently than expected for Synthesis objectives.

Having a generalized conception of a textbook illustration as a horizontal rectangle with distinct actual frame, one would not have anticipated that only 26.8% were horizontal rectangles and 51.8% had actual frames. The more common type of configuration, it turns out, was the Amoeboid, Free-form type, 43.8% of the sample. The Amoeboid, Free-form configuration was typically in an artistic or mechanical medium and was sufficiently abstract to be without background and hence without an overall geometric form or an actual frame. (See Appendix F for examples.) It was essentially a pictorial figure on the white ground of the page (in the same manner as the verbal figures) and had no frame except by implication, Implied frame. One effect of the Amoeboid, Free-form without frame might be to make the illustration less marked off from and more readily associated with the verbal material.

One can examine the following physical attributes of illustrations that were most frequently associated with types of objectives and conceive of instructional situations in which such attributes would be appropriate for such objectives.

Knowledge:	Middle size	High information level	Pictorial elements
Analysis:	Large size	Medium to low level	Pictorial and verbal elements
Synthesis:	Large size	High information level	Pictorial elements
Application:	Small size	Low information level	Pictorial and verbal elements
Appreciation:	Large size	High information level	Pictorial elements

It seems plausible, for example, that for an Analysis objective an illustration should be large enough to reveal its component parts and details; that it should be reduced to relatively low levels of information generally and to the relevant cues in particular; and that the pictured parts to be identified and analyzed should be labelled with verbal elements. It remains to be demonstrated, however, whether such prescriptions of physical types of illustrations would in controlled experimentation yield higher test scores for each type of behavioral objective than other physical types.

With regard to objective level there was a clear polarization within most physical type scales. For example, more low difficulty levels than expected were associated with illustrations having no color or full color, with illustrations having realistic styles, and with illustrations having pictorial elements only. Conversely, more high difficulty levels than expected were associated with illustrations having one to several colors but not full color, having a diagrammatic or other non-realistic style, and having a combination of pictorial elements with verbal and design elements. Apparently, the higher level objectives were for illustrations that tended to be "abstract" with reference to color, style, and elements. This is not surprising if the concepts to be taught are seen as abstractions from the physical world. To the extent that an illustration can "represent" such concepts it must be an abstraction of physical reality or must somehow guide the observer in the abstraction process.

Objective type by verbal modifier type. Although verbal modifiers were not afforded sufficient attention in this study, a few of the significant associations between them and objective types are worth noting. In terms of the major division of verbal modifiers into sentences and non-sentences, illustrations with Knowledge objectives were more frequently than expected associated with more non-sentence modifiers (titles, labels, legends), while illustrations with Synthesis objectives were associated with fewer non-sentences, and those with Analysis and Application objectives were associated with more combinations of both non-sentences and sentences.

One might predict an association as follows between sentence types and objective types: Declarative with Knowledge, Interrogative with Analysis and Synthesis, and Imperative with Application. To a degree this pattern was obtained. More Declarative sentences were associated with Knowledge illustrations than any other, more Interrogative sentences (just barely) were associated with Analysis illustrations than any other, and more Imperative sentences were associated with Application illustrations than any other. However, the only sentence type that occurred more frequently with Synthesis objectives was the combination of Interrogative and Imperative sentences.

The contrast in quantity of verbal modifiers was most marked between illustrations with Application objectives and those with Appreciation objectives. Sentence quantities were larger than expected for Application illustrations and smaller for Appreciation. The same distinction holds for non-sentence modifiers. It would be expected that as the number of sentences or non-sentences increased for a particular illustration that the difficulty level of the objective for that illustration would increase. That prediction was substantiated. Further delineation of the finding in terms of types of verbal modifiers was also obtained. Where there were no sentences or declarative sentences only, the level of objective was more frequently low than expected, while with other sentence types and all combinations of types the level of objective was more frequently high than expected. Where there were no non-sentences or titles only, the level of objective was more frequently low than expected, while with labels only or in combination with titles the level of objective was more frequently high than expected.

The above has been a discussion of the statistical results from the preceding chapter. Several of the issues raised in earlier chapters can now be reexamined in relation to the results.

Comparison with Hickey study. In the related study (reviewed in Chapter III) of textbook graphics by Hickey (6), a profile analysis revealed significant differences ($p < .01$) between the types of graphic stimuli for the three subject areas studied (algebra, biology, music). There was likewise a statistically significant difference between the profiles of graphic responses for the three subject areas. The present study also found significant differences in "graphic" stimuli (illustrations) across subject matters and significant differences in "graphic" responses (behavioral objectives) across subject matters.

Hickey concluded as follows, "What originally appeared to be a rich and varied interaction of graphic, verbal, and symbolic-numeric modes for instruction has been demonstrated to be a limited, stereotyped condition wherein graphics are in fact used only intermittently as supplements to already complete verbal or symbolic-numeric presentations." (6) The critical note in this statement is unmistakable, but its explicit meaning is less so. Is the "limited, stereotyped condition" with reference to the whole sample or to a particular subject matter? The response pattern certainly was stereotyped in the latter sense, i.e., only in music were vocalizing responses called for and only in algebra was numeric problem solving called for. But, one might question this specificity of response to subject as being properly termed "stereotyped." Hickey understandably would desire a sample of greater overall diversity in order to design an instructional device that would be of use in diverse instructional situations. Aside from the design of hardware, it would seem more desirable to seek graphic stimuli and responses that were specific to the subject matter and objectives rather than simply diverse. Diversity may result, but would not be the goal sought. The present study with its 22 scales having 185 points suggests greater diversity in the sample than Hickey observed.

The present study provides no basis for reacting objectively to the judgment, "--graphics are in fact only intermittently used as supplements to already complete verbal or symbolic-numeric presentations." Yet to be established experimentally is the degree to which textbook instruction is "already complete" without graphic stimuli. (This investigator would certainly not question that graphic stimuli frequently appear to be an ancillary aspect of instruction in textbooks.) Data from the present study provide a framework within which to begin investigation of such problems. Behavioral objectives have been assigned each illustration. Testing with eighth-grade subjects could establish the condition (with or without illustrations) under which the behavior would be most likely to appear.

Agreement among judges of objectives. The lack of agreement among judges (participants in the pretest of the objective taxonomy) as to the most appropriate objective for each illustration was noted in Chapter V. There is evidence that the subsequent refinement of the taxonomy, both definitionally and procedurally, increased its reliability. Following are the amounts of teacher agreement using the pretest taxonomy in comparison to those using the final taxonomy.

Pretest--Total agreement 7.5%; Partial agreement 50.0%; No agreement 42.5%

Final--Total agreement 14.1%; Partial agreement 54.9%; No agreement 31.0%

It remains highly plausible to this investigator that some illustrations in their textbook contexts are more univocal in "apparent" objective than others. It assuredly remains to be demonstrated that the total disagreement as to the most appropriate type of objective for 31% of the illustrations is an indictment of either judges or taxonomy. Empirical evidence may subsequently demonstrate that the 31% are multivocal illustrations, being essentially as appropriate for one type of objective as another.

Most scales in this study were non-significantly related to judge agreement. The few significant differences found would suggest that total agreement on objective type was associated more frequently than expected with illustrations of small area, low information level (no natural environment, no shading, limited dimensionality and interior detail), large numbers of non-sentence modifiers (titles, labels, legends), and mathematical subject matter.

Hierarchy of educational objectives. As discussed in Chapter V, one of the departures from the Bloom taxonomy (2) was to separate the level of objectives from the type. The question is: Did the judges make the same separation, i.e., were certain types of objectives judged to be of a higher level than others? As shown in Table 179, the frequency of occurrence of objective levels for illustrations was significantly associated with objective types ($p < .001$).

TABLE 179. CHI-SQUARE FOR OBJECTIVE SCALE 3: BEST TYPE AND OBJECTIVE SCALE 5: BEST LEVEL

Best Objective Type		Best Objective Level			Total
		Limited* 1 & 2	Average 3	Extensive 4 & 5	
Knowledge	1	85(75.6)	85(81.8)	33(45.7)	203
Analysis	2	64(72.2)	87(78.1)	43(43.6)	194
Synthesis	3	35(51.4)	64(55.6)	39(31.0)	138
Application	4	18(35.0)	37(37.9)	39(21.1)	94
Appreciation	5	91(58.8)	44(63.6)	23(35.5)	158
Total		293	317	177	787

$X^2 = 66.74$, $p < .001$

*Names and numbers of points on scales. See Tables 26 and 28 for descriptions of points on the scales.

The most frequently occurring Limited level objectives were for Knowledge and Appreciation illustrations, while the most frequent Extensive level objectives were for Analysis, Synthesis, and Application.

The percentage distribution of objectives of each type across levels would tend to rank the types from lowest (Appreciation) to highest (Application) as follows:

1.	Appreciation	58% Limited level	28% Average level	
2.	Knowledge	42% Limited level	42% Average level	
3.	Analysis	33% Limited level	45% Average level	
4.	Synthesis		46% Average level	28% Extensive level
5.	Application		39% Average level	42% Extensive level

The objective type categories are not defined the same as Bloom's (2), but to the extent the category names are the same the rank order is roughly comparable, except that Application objectives should rank between Knowledge and Analysis according to Bloom.

The desirability of separating type and level assessments of objectives (discussed in Chapter V) remains an open issue. The two were separately assessed for this study, but the above analysis shows that level assessments were significantly related to types. Nonetheless, for this study the separate assessment of objective type and level yielded some very useful data.

CHAPTER IX

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

A six per cent stratified random sample of 787 illustrations from 40 eighth grade textbooks in English, American history, mathematics, and science was classified on eleven physical type scales, five verbal modifier scales, and five objective type and objective level scales. Chi-Square analyses of the consequent frequency distributions yielded the associations noted in what follows.

Because of the large quantity and detailed nature of the results it is feasible here to report only a summary of conclusions, i.e., which scales were significantly associated with which others and which were not. For the specific nature of the relationships the reader will be referred in what follows to particular Chi-Square Tables and to summaries in Chapter VII, Results. Chapter VIII, Discussion may also be of interest.

1. The types of educational objectives assigned the instructional illustrations by expert teachers (knowledge, analysis, synthesis, application, and appreciation) were significantly related to the subject matter (English, history, mathematics, science) of the illustrations. (3 of 3 analyses significant, see Tables 35 to 40 and Summary beginning on page 135.)

2. The judged levels of difficulty (level of learner involvement: limited, average, extensive) of the educational objectives assigned the instructional illustrations was significantly related to the subject

matter (English, history, mathematics, science) of the illustrations. (2 of 2 analyses significant, see Tables 41 to 44 and Summary beginning on page 135.)

3. The physical attributes of the instructional illustrations (area, framing, configuration, position, elements, chroma, achroma, encoding medium, encoding style, and information level) were significantly related to the subject matter (English, history, mathematics, science) of the illustrations. (10 of 11 analyses significant, see Tables 45 to 64 and Summary beginning on page 153.)

4. The verbal modifiers of the instructional illustrations (sentences: declarative, interrogative, imperative, other; non-sentences: titles, labels, legends) were significantly related in type and number to the subject matter (English, history, mathematics, science) of the illustrations (5 of 5 analyses significant, see Tables 66 to 75 and Summary beginning on page 165.)

5. The physical attributes of the instructional illustrations were not significantly related to the amount of agreement among judges (none, partial, total) as to either the most appropriate type of objective or the difficulty level of the objective for the illustrations. (18 of 22 analyses non-significant, see Tables 77-80 and 119-122 for the four significant analyses.)

6. The physical attributes of the instructional illustrations (area, framing, configuration, position, elements, chroma, achroma, encoding medium, encoding style, information level) were significantly related to the type of educational objective (knowledge, analysis, synthesis, application, appreciation) for the illustrations. (19 of

22 analyses significant, see Tables 81 to 118 and Summary beginning on page 231.)

7. The physical attributes of the instructional illustrations (framing, configuration, position, elements, chroma, achroma, encoding medium, encoding style, information level, and unification) were significantly related to the level of difficulty (level of learner involvement: limited, average, extensive) of the objective for the illustrations. (10 of 11 analyses significant, see Tables 123 to 142 and Summary beginning on page 231.)

8. The verbal modifiers of the instructional illustrations were not significantly related to the amounts of agreement among judges (none, partial, total) as to either the most appropriate type of objective or the difficulty level of the objective for the illustrations. (9 of 10 analyses non-significant, see Tables 145 and 146 for the one significant analysis.)

9. The verbal modifiers of the instructional illustrations (sentences: declarative, interrogative, imperative, other; non-sentences: titles, labels, legends) were significantly related both in type and number to the educational objective types (knowledge, analysis, synthesis, application, appreciation) of the illustrations. (10 of 10 analyses significant, see Tables 147 to 166 and Summary beginning on page 268.)

10. The verbal modifiers of the instructional illustrations (sentences: declarative, interrogative, imperative, other; non-sentences: titles, labels, legends) were significantly related both in type and number to the level of difficulty (level of learner involvement: limited, average, extensive) of the illustrations. (5 of 5 analyses significant, see Tables 167 to 176 and Summary beginning on page 268.)

Recommendations

Further development of the taxonomies should be done, adding new scales, refining existing scales.

Further classification and statistical analysis of instructional illustrations should be done, adding illustrations from other sources (filmstrips, programmed materials, etc.), broadening the range of grade levels of the learner (elementary, secondary, college), further diversifying the coverage of subject matter.

But, in the opinion of this investigator, a higher priority requirement is research relating the 185 attributes of illustrations noted herein to the perceptions and learnings of eighth grade students. The present study provides descriptions of many possible stimuli (subject matter, physical attributes, verbal modifiers) as well as a description of possible responses (behavioral objective types) and a prediction by three teachers as to what the "most appropriate" response might be. But, there is no evidence in this study and no substantial evidence elsewhere as to what learner behavior any of these illustrations would probably elicit.

In a sense, the 787 illustrations in this study represent 787 predictions by professional writers, illustrators, and teacher-judges that these particular types of stimuli will elicit particular kinds of responses. What is lacking is experimental confirmation or disconfirmation of these predictions. What can be learned from the experimental assessment of these predictions is probably highly generalizable to other (so-called newer) media which incorporate pictorial stimuli.

A program of such research could culminate in a behavioral taxonomy of pictorial stimuli that would have direct utility for the designer of learning systems. It would describe the pictorial and verbal attributes of illustrations, describe the relevant learner behaviors, and begin to establish the probabilities with which the one would elicit the other. With this kind of information about an instructional systems component of probable importance (regardless of the hardware involved) the instructional systems designer could "program" or "plug-in" the kinds that would meet system specifications. He would be designing at a level well above the trial and error or private intuition level presently available to him.

It is improbable that an instructional system can approximate optimum performance unless the designer of that system is fully informed on the relevant characteristics of the system component options. One of the options will be pictorial stimuli, an option employed on the average every 1.58 pages in modern eighth grade texts. Until now there was no way even to describe systematically such a pictorial stimulus let alone predict what a learner's response to it might be. A beginning on the problem of description has been made, but it will be of little avail to the instructional systems designer without the associated behavioral probabilities.

It matters little whether the so-called systems designer is a psychology professor planning a revised course in perception, a writer or art director for a commercial textbook house, a master teacher for a regionally televised French course, or a member of a national committee of scientists writing an experimental high school curriculum in physics.

Each requires substantial evidence concerning pictorial stimuli--their physical and behavioral attributes as possible components in the instructional "system" being planned.

BIBLIOGRAPHY

1. Ayers, J. Douglas, *Justification of Bloom's Taxonomy by Factor Analysis*, Paper read in Chicago at the February, 1966 national meeting of the American Educational Research Association.

2. Bloom, Benjamin S., editor, *Taxonomy of Educational Objectives, Handbook 1: Cognitive Domain*, David McKay Co., Inc., New York, 1956, 207 pp.

3. Cox, Richard C., and Gordon, John M., *Validation and Uses of the Taxonomy of Educational Objectives: Cognitive Domain*, Paper read in Chicago at the February, 1966 national meeting of the American Educational Research Association.

4. Gagné, Robert M., *The Conditions of Learning*, Holt, Rinehart and Winston, Inc., New York, 1965, 308 pp.

5. Gropper, George L., "Why Is a Picture Worth a Thousand Words?" *Audiovisual Communication Review* 11:75-95, July-August, 1963.

6. Hickey, Albert E., *et al.*, *Requirements for Graphic Teaching Machines*, USOE Title VII Project 899, Northeastern University, Boston, December, 1962, 72 pp.

7. Knowlton, James Q., "On the Definition of 'Picture'," *Audiovisual Communication Review* 14:157-183, Summer, 1966.

8. Krathwohl, David R.; Bloom, Benjamin S.; and Masia, Bertram B., *Taxonomy of Educational Objectives, Handbook II: Affective Domain*, David McKay Co., Inc., New York, 1964, 196 pp.

9. Lewis, Don, and Burke, C. J., "The Use and Misuse of the Chi-Square Test," *Psychological Bulletin* 46:433-489, November, 1949.

10. Lindvall, C. M., editor, *Defining Educational Objectives*, University of Pittsburgh Press, Pittsburgh, Pa., 1964, 83 pp.

11. Mager, Robert F., *Preparing Objectives for Instruction*, Fearon Publishers, San Francisco, 1962, 62 pp.

12. McGuire, Christine, "Research on the Process Approach to the Construction and Analysis of Medical Examinations," *National Council on Measurement in Education Yearbook*, 1963, 20:7-16.

13. McNemar, Quinn, *Psychological Statistics*, John Wiley and Sons, Inc., New York, 1962, 451 pp.

14. Milholland, John E., *Measuring Cognitive Abilities*, Paper read in Chicago at the February, 1966 national meeting of the American Educational Research Association.

15. Rouse, Mary J., *Development and Validation of a Descriptive Scale for Measurement of Art Products*, Cooperative Research Project S-077, Indiana University, 1965, 33 pp., typed.

16. Sanders, Norris M., *A Taxonomy-Based Rationale for the Improvement of the Quality and Variety of Classroom Questions, Assignments, and Examinations*, Paper read in Chicago at the February, 1966 national meeting of the American Educational Research Association.

17. Steckler, Phyllis B., editor, *Textbooks in Print 1965*, R. R. Bowker Co., New York, 1965, 420 pp.

18. Stoker, H. W., and Kropp, R. P., "Measurement of Cognitive Processes," *Journal of Educational Measurement* 1:39-42, June, 1964.

19. University of Illinois, Division of Communications, *How Pictures and Graphs Aid Learning from Print*, Technical Memorandum, Number 4, United States Air Force Human Resources Research Institute, December 30, 1952.

SUMMARY

Problem

Amid all the furor over the new trends in educational technology, the commonplace print media remain largely unchallenged as the most widely used educational resources of all. Great advances have been made in the art and science of printing, but their educational significance is rather less apparent. For example, it is almost indisputable that the lavish use of illustrations makes modern textbooks more attractive, and some research with younger children supports this view. However, the case for older learners is much less well-established, and one wonders what essential educational role the illustrations serve in many of the current printed materials. Illustrations certainly add to the size and cost of books, but what evidence is there that they add proportionately to learning?

The problem is the pervasive but insufficiently analyzed textbook illustration--its characteristics and its role in the teaching-learning process.

Objectives

This study was conceived as a necessary preliminary to the systematic investigation of learning as a function of instructional illustrations. As such its objectives were as follows:

1. Design a taxonomy of instructional illustrations that would include physical types (pictures), verbal modifier types (captions etc.), educational objective types, and subject-matter types.

2. Test and refine the taxonomy with reference to a sample of textbook illustrations.

3. Perform a systematic analysis of a sample of textbook illustrations by tabulating frequencies of occurrence of each type and by assessing the significance of the associations between types.

4. Stimulate the generation of preliminary research questions regarding relations between the identified characteristics of illustrations and the possible associated learning by students.

It was expected, because pictorial stimuli have been a rather unordered domain, that an important yield from this study would be the beginnings of a taxonomy of pictorial stimuli that would be of value to researchers and practitioners attempting to deal systematically with pictures as categorizable stimuli or describable teaching materials.

An ultimate goal would be the discovery of predictive criteria by which designers of textbooks, self-instructional programs, and eventual instructional systems could optimally match the characteristics of illustrations to the other components, man or machine or materials, which together would function with maximum efficiency and effectiveness to meet predetermined educational goals.

Methods

Illustration sample. There were 40 textbooks in the sample, 10 from each of four subject areas (English, history, mathematics, science) at the eighth grade level. The books for each subject were the most recent editions from the ten publishers whose eighth grade textbooks in the subject were the most frequently adopted by the 22 states reporting adoptions. The sample was large enough to include from 48% (history) to 71% (English) of the publishers reported on state adoption lists for the eighth grade.

The eighth grade level was chosen as an approximate midpoint of grade levels (1 through 16), and the four subject matters were chosen to represent a range of subject types and, presumably, a range of illustration types.

The 12,902 illustrations identified in the sample of 40 books were distributed as follows: 11% English, 35% history, 24% mathematics, and 30% science. From this population a 6% proportional random sample was taken which yielded 787 illustrations. This sample was taken by stratum, i.e. by the major subdivisions in each book.

Definitions. One of the more difficult tasks was to conceptualize "illustration" and then to define it operationally. The following three definitions of the elements common to textbook pages were basic to all other definitions.

> Pictorial elements. Those configurations of line, dot, or area and any combination of these three that resembled events or objects (persons, places, and/or things) either as perceived or as generally conceived. Included were the following borderline cases: number lines and geometric figures commonly found in mathematics textbooks; structural formulae in chemistry; curves, graphs, and time lines commonly found in history and science textbooks.
>
> Verbal elements. Those configurations of line, dot, or area and any combination of these three that resembled alphabetical or numerical symbols. Included were pictorial lettering, punctuation marks, and musical and scientific notation systems so long as they were arbitrary, i.e., did not resemble objects or events. Tables were generally included unless they resembled common objects, such as train time-tables.
>
> Design elements. Those configurations of line, dot, or area that did not meet the definition of either pictorial or verbal elements. Those configurations that occurred most frequently

in textbooks seemed to modify or direct attention toward pictorial or verbal elements. Examples were lines around or between areas; arrows; check marks, spheres, stars, etc. at the beginning of paragraphs; and colored or textured areas under pictorial or verbal elements.

These three types of elements were seen as comprising and characterizing areas of the textbook page, an area being an insolable major division of the page. By way of a detailed procedure, each page was divided into pictorial and verbal areas. Operationally, an illustration was equivalent to a pictorial area except that under specified conditions certain pictorial areas could be combined to comprise a single illustration or subdivided to form two or more illustrations. Instructional unity was the criterion for the latter conditions.

Generally speaking, an illustration was what would commonly be considered a "picture" plus interior titles and labels as well as adjacent caption.

Physical type taxonomy. The observable physical attributes of instructional illustrations were many, but 11 types were chosen as reasonably definable and of possible relevance to learner behavior. There resulted 11 physical type scales with a total of 107 sub-categories or points. The titles of the scales were as follows:

1. Area
2. Framing
3. Shape
4. Position
5. Elements
6. Chroma
7. Achroma
8. Encoding Style
9. Encoding Medium
10. Information Level
11. Unification

The above titles are inadequate for a complete understanding of the precise attributes categorized. Reference to Chapter IV and Appendix F of the report is recommended. The taxonomy definitively describes the points on the above scales and gives instructions to follow in classifying illustrations.

A measure was made of the reliability of the scales for naive (prior to studying the instructions) judges. For each of the five ordinal scales Kendall's Coefficient of Concordance (W) was computed from the judgments of three judges with reference to a stratified (by subject matter) random sample of 40 illustrations. The consequent estimates of reliability (W) ranged from .552 to .998. Chi-Square tests indicated that the probability that any of these values could have occurred by chance was $p < .01$. For the six nominal scales the percentage of illustrations for which at least two of the three judges were in agreement ranged from 80% to 100%.

Following each scale in the report are several possible related research questions that may be of interest to other investigators.

The sample of 787 illustrations was categorized on each of the 11 scales by staff judges. The two staff members who were responsible primarily for the physical type taxonomy judged the sample independently and then achieved consensus on their occasional differences. These data were employed in the Chi-Square analysis of the associations between the physical types of the illustrations and the subject matter types and educational objective types.

Objective type taxonomy. Although it was not the intent of this study to design a taxonomy of educational objectives, it was necessary to revise extensively the one chosen. The Bloom taxonomy was chosen over the Gagné and Lindvall alternatives primarily because it had been more widely tested and because its key categories were judged to be more suitable for judges without extensive psychological training.

The particular merit of the revision made of Bloom's taxonomy was the use of the student behavioral objective. Each type of objective was defined by a list of verbs denoting student behaviors as shown in the following:

1. Knowledge--To recall, to recognize, to reproduce (subsequently and essentially as learned) the information obtainable from the illustration
2. Analysis--To separate, to identify, to compare the components of the illustration (physical components or ideational components)
3. Synthesis--To combine, to formulate new relationships, to generalize from information obtained in the illustration
4. Application--To use information (known or given) that involves the illustration (but not for the purpose of analysis and synthesis
5. Appreciation--To show desirable interest, attitude, attention toward the illustration or its subject matter.

A judge choosing to write the objective, "to recall the names of the parts of the human circulatory system," had in effect chosen a Knowledge type objective because of his use of the infinitive "to recall." He further had expressed the objective in terms of the observable (more or less) behavior of the learner.

As can be seen, not all of Bloom's cognitive categories were used and those selected were defined quite differently. The full taxonomy is a considerable expansion of the above including many more infinitives and providing example illustrations and objectives of each type. A major departure from the cognitive domain was the addition of the Appreciation category (in lieu of the Affective Domain), which was at once both necessary and undesirable--necessary because many illustrations seemed to have no apparent cognitive intent and undesirable because of the impossibility of behavioral definition comparable to the cognitive categories.

A preliminary version of the objective taxonomy was pretested with 15 eighth-grade teachers. Responses of these teachers were used to revise the taxonomy and the procedure for using it.

The final judges of the most appropriate objective for each of the 787 illustrations were 24 eighth-grade teachers from three Indiana school systems of different sizes. The teachers were chosen by their administrators using a criterion of excellence in classroom teaching. The eight teachers in each system wrote objectives for all 787 illustrations, or about 100 objectives apiece. Repetition of this process in each school system produced three objectives for each illustration. From these three, the research staff who were primarily responsible for developing the taxonomy and who had also been teachers of the subject matter being judged chose the one best objective. For all judges, the criterion was: What is the most appropriate type of behavior to expect from the student? The rationale for answering this question included a basis for conceiving of the student's prior knowledge and ability.

In the Bloom taxonomy the categories are hierarchically arranged, each category being a prerequisite of the one following. Objectives in this study were not conceived as hierarchical except as each was rated by teacher judges on a scale of 1 to 5 for relative difficulty, or more specifically, for level of involvement. Level of involvement was explicated as the relative duration and intensity of the student's involvement in meeting the objective.

At least two of three of the teacher-judges were in agreement as to the most appropriate objective type for each illustration in 69% of the cases. One of the more plausible reasons the judgments were not more reliable was that some illustrations may not be univocal as to objective type but rather may be suitable for several types of objectives.

For the Chi-Square analyses the objective type and objective level data were cast into five scales as follows:

1. Objective Type Agreement--classified illustrations according to the amount of agreement among the three judges as to the most appropriate type of objective
2. Objective Type Pattern--classified illustrations according to the pattern of types assigned them by the three teacher-judges
3. Best Objective Type--classified illustrations according to the type of objective chosen as "best" by staff judges from among the three written by teacher-judges
4. Objective Level Agreement--classified illustrations according to the amount of agreement among the three judges as to the level of the objective

5. Best Objective Level--classified illustrations according to the "best" level, which was the mathematical average of the levels (1-5) assigned by the three teacher-judges.

__Verbal__ __modifier__ __taxonomy__. All the verbal elements that were a part of the illustrations, i.e., within the picture or caption, were identified and counted by staff judges. The main categories were essentially as follows:

1. Sentences (usually captions)--common English grammer criterion
    Sub-categories--Declarative, Interrogative, etc.
2. Non-sentences--did not meet criterion for sentence
    Referred to the whole illustration (usually titles)
    Referred to part of illustration (usually labels)
    Referred to either but including a key (legends)

Verbal modifiers were cast in the following scales for the Chi-Square analyses:

1. Verbal Modifier Type--classified illustrations as having sentences, non-sentences, or both
2. Sentence Pattern--classified illustrations according to the pattern of sentence types (declarative, interrogative, etc.) whether singly or in combination
3. Sentence Quantity--classified illustrations according to the number of modifying sentences
4. Non-sentence Pattern--classified illustrations according to the pattern of non-sentence types (titles, labels, legends) whether singly or in combination

5. Non-sentence Quantity--classified illustrations according to the number of modifying non-sentences.

Subject-matter taxonomy. One scale was included which classified illustrations according to their broad subject matter area--English, history, mathematics, science.

Results

Chi-Square analyses were made to test the independence of each pair of scales. From the total of 22 scales (1 subject-matter scale, 11 physical types scales, 5 objective type and level scales, and 5 verbal modifier scales), there resulted a computer run which included a total of 231 analyses. It was necessary to choose from these the analyses that had direct relevance to the central question, which was: given certain subject matters and certain objectives, how have the pictorial and verbal elements been, as a consequence, selected and manipulated in the design of appropriate textbook illustrations? More explicit questions would include: What type of educational objective was most frequently assigned to science illustrations? What kind of modifying sentence occurred more frequently than expected for analysis objectives? Statistically speaking, were physical types or verbal modifier types independent of subject matter types or objective types?

To answer each question the relevant results (101 Chi-Square analyses) were organized for the report under the following headings:

1. Subject matter by Objective type
2. Subject matter by Physical type
3. Subject matter by Verbal modifier type

4. Objective type by Physical type

5. Objective type by Verbal modifier type

Because the reported results were detailed and massive, the following discussion is highly selective.

Subject matter by objective type. Five Chi-Square analyses dealt with the question: did the educational objectives assigned to illustrations vary in relation to the subject matter of those illustrations? All five associations were found to be significant, $p < .05$.

The largest deviations of actual from expected (theoretical) frequencies were for mathematics illustrations, there being 17.4% more Application type objectives than expected for mathematics and 9.6% more Extensive (high) level objectives for mathematics than expected.

Some of the results did not seem consistent with the subject matter. For example, the most frequently occurring objectives for science illustrations were Knowledge (recall of facts) and Appreciation. Fewer science illustrations had Analysis objectives than expected.

Subject matter by physical type. Eleven Chi-Square analyses dealt with the question: did the physical attributes of the illustrations vary in relation to the subject matter of the illustrations? Ten of the 11 associations were significant, $p < .001$.

In most of the analyses (75%) the largest deviations from expected (theoretical) frequencies were for mathematics illustrations and the smallest were for science illustrations. For example, the largest deviation of actual from expected frequencies of encoding styles was as follows for illustrations of each subject:

English--34.5% fewer Diagrammatic
History--19.5% more Realistic
Mathematics--52.4% more Diagrammatic
Science--8.9% more Realistic

The typical or most frequently occurring science illustration: was Amoeboid, Free form in configuration; was located in the upper 2/3 of the page; contained pictorial elements only; was either Mono- or Duochromatic; was Mono-achromatic; was in an Artistic medium; had a Realistic style; and was at a High information level.

It might be anticipated that the more formal disciplines (English and mathematics) would be illustrated more abstractly than history and science. This anticipation was partially confirmed in that no mathematics illustrations and only 4% of English illustrations were in the photographic medium. Further evidence can be seen in the fact that the most frequently occurring pattern of deviations was one in which English and mathematics illustrations were alike and in contrast to history and science illustrations. For example, while there were fewer Full-chromatic illustrations (such as color photos) than expected for English and mathematics, there were more for history and science. Mathematics illustrations were not without color, however, for there were 16.7% more Mono- and Duo-chromatic illustrations in mathematics than expected. The relevance of color attributes to mathematics concepts was not apparent.

Subject matter by verbal modifier type. Five Chi-Square analyses dealt with the following question: do the verbal modifiers of the illustrations vary in relation to the subject matter of the illustrations? All five associations were found to be significant, $p < .001$.

Only 5.5% of the sample had no verbal modifiers, as defined in the study, while 52.6% had both sentence and non-sentence types of verbal modifiers.

The deviations of actual from expected (theoretical) frequencies were generally largest for mathematics illustrations and smallest for science illustrations. For example, the largest deviation from expected frequencies of verbal modifiers (for illustrations of each subject) was as follows:

English--12.6% less with both Sentences and Non-sentences

History--11.5% more Sentences

Mathematics--15.3% more with both Sentences and Non-sentences

Science--2.3% more Non-sentences

The declarative sentence was the most frequently occurring type of sentence for all subjects except mathematics, for which the most frequent was a combination of three or more types of sentences. In only 5% of the illustrations were the modifying sentences of interrogative or imperative type. These data suggest a predominant role of passive acceptance for the learner in relation to illustrations. In 23% of the illustrations a declarative sentence was combined with interrogative, imperative, or both--a situation more conducive to learner involvement.

Labels were the most frequently occurring non-sentence type for all subjects except history for which titles were the most frequent.

Mathematics illustrations were unique in including larger quantities of both sentences and non-sentences than expected, although this is largely attributable to the fact that so many mathematics illustrations were actually problems and as such included large amounts of verbal material.

English was the only subject having more illustrations than expected with no verbal modifiers--no captions, labels, titles, or legends. There was no apparent explanation for this finding.

Objective type by physical type. There were 55 Chi-Square analyses that tested the independence of the 11 physical types scales from the five objective type scales. They dealt with the question: did the physical attributes of the illustrations vary in relation to the educational objectives assigned those illustrations? Approximately 60% of the associations were significant, $p < .05$.

The non-significant relationships were primarily (18 of 22 analyses) those involving the amount of judge agreement as to the most appropriate type or level of objective for the illustrations. In only four of 22 analyses was there a significant association between the physical type of the illustrations and the judges' tendency to agree on objectives.

However, the type of objectives judged appropriate for the illustrations was generally (9 of 11 scales) found to be significantly related to the physical attributes of the illustrations. Likewise, the judged difficulty level (level of involvement) of the objectives was generally (10 of 11 scales) found to be significantly related to the physical attributes of the illustrations.

In all analyses of objective type that yielded significant differences, the largest deviations of actual from expected (theoretical) frequencies were either for Application or Appreciation objectives, and in most cases these were in contrast.

For example, the largest deviation from expected frequencies of achromatic types was as follows for illustrations of each objective type:

Knowledge--3.4% more Tri- and Poly-achromatic

Analysis--8.9% less Full-achromatic

Synthesis--9.4% more Tri- and Poly-achromatic

Application--21.5% more Mono-achromatic; 14.3% fewer Full-achromatic

Appreciation--14.0% less Mono-achromatic; 16.3% more Full-achromatic

A Mono-achromatic illustration would be black or one shade of grey while a Full-achromatic illustration would have a full range of greys like a photograph.

The most frequent pattern of deviations was one in which Knowledge, Analysis, and Application objectives were in one direction while Synthesis and Appreciation were in the other. For example, while fewer illustrations than expected with pictorial elements only had Knowledge, Analysis, and Application objectives, more illustrations than expected with pictorial elements only had Synthesis and Appreciation objectives.

With regard to objective level there was a clear polarization within most physical type scales. For example, more low difficulty levels than expected were associated with illustrations having no color or full color, with illustrations having realistic styles, and with illustrations having pictorial elements only. Conversely, more high difficulty levels than expected were associated with illustrations having one to several colors but not full color, having a diagrammatic or other non-realistic style, and having a combination of pictorial elements with verbal and design elements. Apparently, the higher level objectives were for illustrations that tended to be "abstract" with reference to color, style, and elements.

Unanticipated was the finding that, while Mono- and Duo-chromatic illustrations were the most frequently occurring for all other objective types, the Non-chromatic was most frequent for Appreciation objectives. The Full-chromatic illustrations, which might have been anticipated for Appreciation objectives, were instead found more frequently than expected for Synthesis objectives.

Objective type by verbal modifier type. There were 25 Chi-Square analyses that tested the independence of the five verbal modifier scales from the five objective type and level scales. They dealt with the question: did the verbal modifiers of the illustrations vary in relation to the educational objectives assigned those illustrations? Approximately 60% of the associations were significant, $p < .01$.

The 9 non-significant results were related to two scales, Objective Type Agreement and Objective Level Agreement. Thus, there was little demonstrated relationship between the amount of agreement by teacher-judges and the verbal modifiers of the illustrations they judged.

For objective types, the most frequently occurring pattern of deviation of actual from expected (theoretical) frequencies was one in which Knowledge and Appreciation deviations were in one direction, while Analysis, Synthesis, and Application deviations were in the other. For example, while fewer illustrations than expected with Knowledge and Appreciation objectives contained three or more types of sentences, more illustrations with Analysis, Synthesis, and Application objectives contained three or more types of sentences.

The relationship between verbal modifiers and objective levels was pronounced. The illustration with higher level objectives, for example, had more than expected of both types of verbal modifiers together (sentences and non-sentences) and less of each type alone. Of the illustrations having sentence modifiers there were more at lower levels than expected with Declarative sentences only and more at higher levels with Interrogative, Imperative, and all combinations of two, three, or four sentence types. Of the illustrations having non-sentence modifiers, more at low levels than expected had titles only, while more at high levels had labels only or a combination of both.

For both sentences and non-sentences, the illustrations with small quantities were associated more frequently than expected with low objective levels and those with large quantities were associated more frequently with high objective levels. Thus, the level of difficulty of the objective assigned each illustration was positively related to the number of types of verbal modifiers and to the overall number of verbal modifiers associated with the illustrations.

Conclusions

In sum, the overall conclusions from this study are four:

1. The frequency of occurrence of the educational objective types and objective levels for illustrations was significantly associated with the English, history, mathematics and science subject matter of the illustrations.

2. The frequency of occurrence of the physical attributes of illustrations and the verbal modifiers of illustrations was significantly associated with the English, history, mathematics and science subject matter of the illustrations.

3. The frequency of occurrence of the physical attributes of illustrations and the verbal modifiers of illustrations was significantly associated with the Knowledge, Analysis, Synthesis, Application, and Appreciation objectives of the illustrations.

4. The frequency of occurrence of the physical attributes of illustrations and the verbal modifiers of illustrations was significantly associated with the Limited, Average, and Extensive Levels of Involvement (relative difficulty of objectives) of the illustrations.

In addition, certain other statements can be made:

1. The physical attributes of illustrations can be classified on 11 scales by relatively naive judges with results adequately reliable for many purposes.

2. Student behavioral objectives of five types can be written for textbook illustrations by experienced teachers who have received minimum training with the taxonomy.

3. The separate assessment of objective type and objective level can yield useful data even though the two assessments are not independent.

4. The verbal modifiers of illustrations, as defined in this study, can be identified and classified with adequate reliability for many purposes.

5. Other investigators may be interested in the questions raised throughout the study (and stated in the final report) which suggest a diversity of directions for experimental studies.

6. The editors of textbooks and the designers of other instructional materials incorporating illustrations may find useful the tables in the summaries of each section of the Results Chapter (beginning on

pages 153, 165, 231, and 268). The tables show what type of picture and what type of verbal material was most common for each kind of subject matter and for each kind of educational objective.

Recommendations and Implications

1. It would be of value to both the educational research community and the educational development community to extend and refine the taxonomic beginnings made in this study. Educational objectives, subject matter (particularly the structures of knowledge and inquiry), and pictorial and verbal stimuli all require further analysis before superior instructional systems can be designed.

2. In view of the pervasiveness of illustrations in modern textbooks (there being an average of 1 illustration every 1.58 pages in the sample) and the dearth of experimental evidence concerning their relevance to learning, instructional illustrations should be given intensive experimental study.

3. Each of the many significant individual associations found in this study between types of illustrations and types of subject matter and educational objectives is only an indication of a present practice by publishers or at best an unsubstantiated hypothesis by authors, editors, and artists. Each requires experimental confirmation or disconfirmation.

4. It is improbable that an instructional system can approximate optimum performance unless the designer of that system is fully informed on the relevant characteristics of the system component options.

Pictorial stimuli will be one of the system component options the designer will select to meet certain system specifications. Available for the designer to date are very few guidelines for even the adequate description of pictorial stimuli, and fewer still for the prediction of the behavioral consequences of the addition or deletion of pictorial components for an instructional system. It matters little whether the so-called systems designer is a Psychology professor planning a revised course in perception, a writer or art director for a commercial textbook house, a master teacher for a regionally televised French course, or a member of a national committee of scientists writing an experimental high school curriculum in physics; each requires substantial evidence concerning pictorial stimuli--their physical and behavioral attributes as possible components in the instructional "system" being planned.

APPENDIX A

STATES SUPPLYING TEXTBOOK ADOPTION DATA

1. Alabama
2. Alaska
3. Arizona
4. Arkansas
5. California
6. Delaware
7. Florida
8. Idaho
9. Indiana
10. Kansas
11. Kentucky
12. Louisiana
13. Mississippi
14. Nevada
15. North Carolina
16. Oklahoma
17. Oregon
18. South Carolina
19. Tennessee
20. Texas
21. Utah
22. West Virginia

APPENDIX B

TEXTBOOKS IN SAMPLE

English Textbooks

1. Wolfe, Josephine B., and Ryan, Thomas A., English Your Language, 8, Allyn and Bacon, Inc., 1964.
2. Bailey, Matilda, and Walker, Lalla, Our English Language, 8, American Book Company, 1963.
3. Warriner, John E., and others, English Grammar and Composition, 8, Harcourt, Brace and World, Inc., 1965.
4. Greene, Harry A., and others, Building Better English, 8, Harper and Row, Inc., 1965.
5. Tressler, J. C., and others, Junior English in Action, Book 2, D. C. Heath and Company, 1960.
6. Postman, Neil, and Damon, Howard C., The Uses of Language, Holt, Rinehart and Winston, Inc., 1965.
7. Shane, Harold G., and others, Using Good English, 8, Laidlaw Brothers, 1964.
8. Pollock, Thomas C., and others, The Macmillan English Series, 8, Macmillan Company, 1963.
9. McKee, Paul, and others, English for Meaning, 8, Houghton Mifflin Company, 1962.
10. Wolfe, Don M., and others, Enjoying English 8, L. W. Singer Company, Inc., 1965.

History Textbooks

11. West, W. M., and R., and Gardner, W. E., Story of Our Country, Allyn and Bacon, Inc., 1963.
12. Drummond, Donald F., and others, Five Centuries in America, American Book Company, 1964.
13. Winther, Oscar O., and Cartwright, William H., The Story of Our Heritage, Ginn and Company, 1962.

14. Casner, Mabel B., and others, Story of the American Nation, Harcourt, Brace and World, Inc., 1964.

15. Hartman, Gertrude, and others, America--Land of Freedom, D. C. Heath and Company, 1961.

16. Eibling, Harold H., and others, History of Our United States, Laidlaw Brothers, 1965.

17. Clark, Thomas D., and others, Freedom's Frontier, Lyons and Carnahan, Inc., 1962.

18. McGuire, Edna, and Portwood, Thomas B., Our Free Nation, The Macmillan Company, 1961.

19. Wilder, Howard B., and others, This Is America's Story, Houghton Mifflin Company, 1964.

20. Liebman, Rebekah, and Young, Gertrude A., The Growth of America, Prentice-Hall, Inc., 1964.

Mathematics Textbooks

21. Brumfiel, Charles F., and others, Introduction to Mathematics, Addison-Wesley Company, Inc., 1963.

22. Deans, Edwina, and others, Extending Mathematics, American Book Company, 1963.

23. Buswell, Guy T., and others, Arithmetic We Need, Ginn and Company, 1963.

24. Clark, John R., and others, Growth in Arithmetic, Harcourt, Brace and World, Inc., 1962.

25. Haag, Vincent H., and Dudley, Edwin A., Introduction to Secondary Mathematics, Vol. 2, D. C. Heath and Company, 1965.

26. Keedy, Mervin L., and others, Exploring Modern Mathematics, Book 2, Holt, Rinehart and Winston, Inc., 1963.

27. McSwain, E. T., and others, Mathematics 8, Laidlaw Brothers, 1965.

28. Mayor, John R., and others, Contemporary Mathematics, Second Course, Prentice-Hall, Inc., 1964.

29. Van Engen, Henry, and others, Seeing Through Mathematics, Book 2, Scott, Foresman and Company, 1963.

30. Rosskopf, Myron F., Modern Mathematics--Through Discovery, Book 2, Silver Burdett Company, 1964.

Science Textbooks

31. Smith, Paul E., and others, Our Environment--How We Adapt Ourselves to It, Allyn and Bacon, Inc., 1964.

32. Jacobson, Willard J., and others, Broadening Worlds of Science, American Book Company, 1964.

33. Brandwein, Paul F., and others, The World of Matter--Energy, Harcourt, Brace and World, Inc., 1964.

34. Navarra, John G., and Garone, John E., Today's Basic Science--The Atom and the Earth, Harper and Row, Inc., 1965.

35. Schneider, Herman, and Nina, Science and Your Future, D. C. Heath and Company, 1964.

36. Davis, Ira C., and others, Science 2, Experiment and Discovery, Holt, Rinehart and Winston, Inc., 1965.

37. Smith, Victor C., Understanding Science for the Space Age, J. B. Lippincott Company, 1962.

38. Barnard, J. Darrell, and others, Science: A Way to Solve Problems, Macmillan Company, 1962.

39. Beauchamp, Wilbur L., and others, Science Is Understanding, Scott, Foresman and Company, 1964.

40. MacCracken, Helen Dolman, Scientists Solve Problems, L. W. Singer Company, Inc., 1962.

APPENDIX C

PUBLISHERS IN SAMPLE

1. Addison-Wesley Publishing Company
2. Allyn and Bacon, Inc.
3. American Book Company
4. Ginn and Company
5. Harcourt, Brace and World, Inc.
6. Harper and Row, Publishers
7. D. C. Heath and Company
8. Holt, Rinehart and Winston, Inc.
9. Laidlaw Brothers
10. J. B. Lippincott Company
11. Lyons and Carnahan
12. Macmillan Company
13. Houghton Mifflin Company
14. Prentice-Hall, Inc.
15. Scott, Foresman and Company
16. Silver Burdett Company
17. L. W. Singer, Inc.

APPENDIX D

PROCEDURE FOR IDENTIFYING ILLUSTRATIONS

Directions

1. Begin at page 1 (Arabic) of the text (omitting any preceding pages with Roman numerals) and proceed page-by-page through the entire book.

2. Consider each page singly.

3. However, two adjacent pages which meet one or more of the following criteria will be considered as "one page" throughout this procedure, but the two back-to-back surfaces of one page will never be so treated.

   A. Picture or title extends across the spline to the adjacent page.

   B. Picture on adjacent pages are related to a common caption or title.

   C. Picture on adjacent pages are instructionally unified, i.e.,
      a sequence or series such as a procedure or process
      a comparison or change with time
      an enumeration or group of examples.

4. Count the number of units of analysis, as established by question 1-5 to follow, and number them consecutively (1-n) for each stratum.

Procedure

1. What kind(s) of element(s) does the page contain?

   A. Verbal elements only or with design elements--go to next page.

   B. Pictorial elements only or with design elements--the page is a unit of analysis. Number it.

   C. Pictorial and verbal elements only or with design elements--go to number 2.

2. What kinds of verbal areas does the pictorial plus verbal page contain?

   A. Title(s) and/or caption(s) only--the page is a unit of analysis. Number it.

B. Text only or with titles and/or captions--Draw lines (imaginary) separating the verbal areas (title, caption, text) from the pictorial areas at the borders where they are contiguous. The pictorial areas should include any internal titles and labels. (Contiguous pictorial areas having 50% or more of a border in common are considered one area.)

The page has now been divided (by imaginary lines) into one or more pictorial areas and one or more verbal areas. Go to number 3.

3. Are any of the pictorial areas part of an exercise, experiment, question, or problem?

   A. Yes--the pictorial area(s), or part of same, related to each numbered exercise, experiment, question, or problem is (are) a separate unit of analysis. Number each.

   B. No--go to number 4 for each remaining pictorial area.

4. How many captions in the pictorial area?

   A. None or one--the area is a unit of analysis. Number it.

   B. Two or more--go to number 5.

5. Are the separately captioned pictorial units in the area instructionally unified, i.e., a sequence or series such as a procedure or
   process?
   a comparison or change with time?
   an enumeration or group of examples?

   A. Yes--the area is a unit of analysis. Number it.

   B. No--the part of the area associated with each caption is a separate unit of analysis. Number each one.

APPENDIX E

ILLUSTRATION SAMPLE

Illustration	Book*	Page	Illustration	Book	Page
1	1	16	36	5	12
2	1	80	37	5	34
3	1	104	38	5	86
4	1	149	39	5	139
5	1	248 top	40	5	168-9
6	1	327 whole page	41	5	217
7	1	462	42	5	239 both
8	2	20	43	5	255
9	2	30-31	44	5	307 both
10	2	52	45	5	339
11	2	100 all in margin	46	5	353
12	2	111	47	5	387
13	2	130-131	48	5	436
14	2	179 top cartoon	49	6	5
15	2	201 all in margin	50	6	78
16	2	227 bottom margin	51	6	121
17	2	232	52	6	212 whole page
18	2	266	53	7	18
19	2	293 margin	54	7	44
20	2	317	55	7	96
21	2	343 top letter	56	7	118
22	2	360	57	7	171
23	3	467	58	7	200
24	4	41 chart	59	7	242
25	4	53	60	7	268
26	4	84 whole page	61	7	305
27	4	169	62	7	355 both envelopes
28	4	227 whole page	63	7	390 with poem
29	4	243	64	8	0
30	4	273	65	8	65
31	4	329	66	8	122
32	4	354 top	67	8	149 invitation
33	4	374 bottom letter	68	8	173
34	4	402	69	8	222
35	4	437 whole page	70	8	294

---

*See Appendix B.

Illustration	Book	Page
71	8	383
72	9	13 bottom
73	9	31
74	9	53
75	9	81 bottom 3
76	9	119
77	9	131 bottom
78	9	137
79	9	189
80	9	268
81	9	312
82	9	353
83	9	373
84	9	392
85	9	432
86	10	29 with story
87	10	58 with story
88	10	91
89	10	125
90	10	191
91	10	218
92	10	237
93	10	254 with story
94	10	282
95	10	319
96	11	11
97	11	21
98	11	50
99	11	90
100	11	93
101	11	136 bottom
102	11	149 bottom
103	11	152 top
104	11	175 top & bottom
105	11	186 both
106	11	208
107	11	286 bottom
108	11	287 top
109	11	293 both
110	11	298
111	11	332
112	11	382
113	11	390
114	11	415
115	11	428-9 all
116	11	452
117	11	453
118	11	536
119	11	543
120	11	561
121	11	566 middle
122	11	577
123	11	611 whole page
124	12	5 both
125	12	53
126	12	79
127	12	81
128	12	146
129	12	160
130	12	196-7 all
131	12	201
132	12	269
133	12	278
134	12	332
135	12	391
136	12	414
137	12	477
138	12	526
139	12	563
140	12	566 both
141	12	647
142	13	37
143	13	40
144	13	81
145	13	95
146	13	115 both
147	13	118
148	13	157
149	13	177 bottom
150	13	192 all 4

Illustration	Book	Page
151	13	208
152	13	233
153	13	273 top
154	13	278
155	13	297
156	13	365
157	13	400
158	13	407
159	13	443
160	13	466
161	13	468 bottom
162	13	484
163	13	501
164	13	518
165	13	549
166	13	571
167	13	588
168	13	592
169	13	642
170	13	647
171	13	675 top
172	13	690
173	13	714
174	13	751
175	14	13 all in frame
176	14	51 all in frame
177	14	72
178	14	79 all in frame
179	14	107
180	14	121 whole page
181	14	128
182	14	240
183	14	268
184	14	270
185	14	286
186	14	307
187	14	352-3 all
188	14	370 all in frame
189	14	379
190	14	384
191	14	393
192	14	450
193	14	477
194	14	495 all in frame
195	14	539
196	14	555
197	14	571
198	14	584
199	14	591
200	14	683
201	14	689
202	14	723 top
203	14	773
204	14	780
205	15	1 whole page
206	15	32
207	15	80
208	15	103 whole page
209	15	116
210	15	182
211	15	201 both
212	15	231 whole page
213	15	263 whole page
214	15	277
215	15	328 both
216	15	345
217	15	407
218	15	429 whole page
219	15	435 whole page
220	15	483
221	15	524 left
222	15	531 top
223	15	552
224	15	602 left
225	15	640
226	15	662
227	15	682
228	16	24
229	16	33
230	16	36 col 2 #2

Illustration	Book	Page	Illustration	Book	Page
231	16	36 col 1 #2	271	17	98
232	16	71	272	17	144
233	16	83 top left	273	17	149 both
234	16	103	274	17	204
235	16	110	275	17	205
236	16	114	276	17	250 bottom
237	16	140	277	17	281
238	16	150	278	17	309 both
239	16	167	279	17	329
240	16	195	280	17	353
241	16	225	281	17	401
242	16	238-9	282	17	414
243	16	258	283	17	441 top
244	16	264 whole page	284	17	448
245	16	297	285	17	545
246	16	315 top	286	17	584 both
247	16	322-3	287	17	630
248	16	339	288	17	643
249	16	344	289	17	677
250	16	356 with shaded area	290	17	688-9 bottom
251	16	378 top	291	17	726
252	16	378 middle & bottom	292	17	728
253	16	382 all 4	293	17	782
254	16	395	294	18	2-3
255	16	430	295	18	34
256	16	450 both	296	18	43
257	16	461	297	18	100
258	16	486 with poem	298	18	135
259	16	500	299	18	151
260	16	505	300	18	194
261	16	522	301	18	229
262	16	555 last	302	18	297
263	16	572	303	18	332
264	16	601 whole page	304	18	334
265	16	613 all 3	305	18	374
266	16	622	306	18	401
267	16	632 bottom 2	307	18	420-1 all
268	17	12	308	18	492
269	17	14	309	18	499
270	17	29 left	310	18	518

Illustration	Book	Page	Illustration	Book	Page
311	18	536	351	19	657
312	18	672	352	20	28 top
313	18	708 all in margin	353	20	32
314	18	721 lower right	354	20	64
315	18	731 bottom	355	20	83
316	18	733	356	20	128
317	18	735	357	20	137
318	19	0-1 all	358	20	140 top
319	19	26	359	20	166D whole page
320	19	46	360	20	197 bottom
321	19	101 with time line	361	20	209
322	19	103 whole page	362	20	213
323	19	114	363	20	242 bottom
324	19	124	364	20	257
325	19	134-5 all	365	20	273 both
326	19	159	366	20	279 top
327	19	168	367	20	319
328	19	182 with time line	368	20	352 right
329	19	212	369	20	364 top
330	19	218	370	20	378 top
331	19	273	371	20	380 both
332	19	286	372	20	402-3 all
333	19	305 with time line	373	20	428
334	19	336	374	21	5
335	19	353	375	21	58
336	19	358	376	21	109 bottom
337	19	401 bottom	377	21	132 top
338	19	404	378	21	139 bottom
339	19	432 IL	379	21	190
340	19	434	380	21	220
341	19	449	381	21	245 fig. 21-3
342	19	475	382	21	257 fig. 21-35
343	19	493	383	21	270 last
344	19	526 with time line	384	21	279 first
345	19	548	385	21	291 fig. 24-38
346	19	566 both	386	21	296 first
347	19	584	387	21	305 fig. 55 to 58
348	19	627 both	388	21	310 left
349	19	629	389	21	358 last
350	19	650	390	21	360 prob. 6

Illustration	Book	Page
391	21	362 last
392	22	50 first
393	22	51 first
394	22	80 third
395	22	86 ex. 10
396	22	133 last
397	22	144 middle 2
398	22	150 ex. 1-7
399	22	152 last of 3
400	22	155 last of 4
401	22	169 last of 2
402	22	203 second of 3
403	22	254
404	22	270 bottom
405	22	298 last of 2
406	22	302 ex. 17
407	22	304 last of 2
408	22	316 last of 6
409	22	321 ex. 17
410	22	325 second of 4
411	22	327 b
412	22	330 first of 3
413	22	343 first of 2
414	22	346 all
415	22	373
416	22	400 a-c
417	23	24
418	23	32 top 3
419	23	78 top half
420	23	144 prob. 1
421	23	146 prob. 4
422	23	195 prob. 3
423	23	200 prob. 1
424	23	201 prob. 10, 11
425	23	242
426	23	337 prob. 6, 7
427	24	23 bottom
428	24	31 prob. 4
429	24	47 top
430	24	82 prob. 2
431	24	83 prob. 5
432	24	118 prob. 10
433	24	135 prob. 1
434	24	148 fig. 8
435	24	148 fig. 9
436	24	149 prob. 7
437	24	153 prob. 14
438	24	155 prob. 3
439	24	163 prob. 10
440	24	166 prob. 6
441	24	172 prob. 2
442	24	175 prob. 2
443	24	201 first of 2
444	24	203
445	24	230 prob. 6
446	24	230 prob. 7
447	24	233 prob. 10
448	24	242 top two
449	24	257
450	24	262 last of 2
451	24	263
452	24	287 last of 2
453	24	295
454	24	312
455	24	339 second of 3
456	24	346 top col. 2
457	24	350 second of 9
458	24	358 ex. 6
459	24	360 ninth of 10
460	24	372 prob. 13
461	25	37 second of 2
462	25	83 first of 2
463	25	147 ex. 9
464	25	155 ex. 4
465	25	170 ex. 8
466	25	171 ex. 3
467	25	204 ex. 1-4
468	25	206 ex. 10
469	25	207 ex. 11
470	25	218 ex. 5

Illustration	Book	Page	Illustration	Book	Page
471	25	225 ex. 8	511	27	352 second of 3
472	25	243 all 3	512	28	19
473	25	247 ex. 5	513	28	69 last of 2
474	25	268 ex. 9	514	28	97 ex. 6
475	25	291 ex. 3	515	28	108 ex. 1
476	25	317 ex. 12	516	28	134
477	26	42	517	28	137 last of 3
478	26	66 step 1-3	518	28	163 last of 2
479	26	72 third of 4	519	28	165 bottom
480	26	74 second of 2	520	28	170 first of 2
481	26	88 second of 5	521	28	250 first of 2
482	26	94 first of 2	522	28	255
483	26	212 first of 2	523	28	264 last of 3
484	26	231 last of 3	524	28	274 last of 2
485	26	235	525	28	275 first of 3
486	26	245 last of 3	526	28	297
487	26	421	527	28	327 first of 2
488	27	6 right column	528	29	6
489	27	44 first of 6	529	29	57 first of 2
490	27	48 first of 5	530	29	67
491	27	62 second of 2	531	29	74 D4
492	27	153	532	29	113 last of 2
493	27	158 first of 4	533	29	226
494	27	159 top right	534	29	268 D1 & 2
495	27	161 last of 3	535	29	283
496	27	167 top	536	29	299 D7
497	27	188 prob. 4	537	29	357
498	27	191 first of 2	538	29	370 D2
499	27	195 left col. top	539	29	383 D1 & 2
500	27	214 first of 2	540	29	392 D3
501	27	221 top	541	30	1
502	27	223 last of two	542	30	34 top
503	27	231 top	543	30	80
504	27	257 prob. 6	544	30	120
505	27	273 prob. 3	545	30	157 second of 3
506	27	279	546	30	186 second of 2
507	27	302 third of 5	547	30	187 first of 3
508	27	309 last of 2	548	30	196 first of 2
509	27	324 right	549	30	197 first of 2
510	27	352 first of 3	550	30	220 first of 2

Illustration	Book	Page	Illustration	Book	Page
551	30	243 last of 2	591	32	211 last of 2
552	30	268 last of 2	592	32	217
553	30	313	593	32	229
554	30	332 last of 2	594	32	252
555	30	349 first of 2	595	32	273
556	30	351 first of 2	596	32	295
557	30	375	597	32	317
558	31	33	598	32	340 all
559	31	41	599	32	375 top
560	31	52	600	32	379 bottom
561	31	88	601	32	398-9
562	31	122	602	32	431
563	31	125	603	32	449
564	31	147 last of 2	604	32	483
565	31	166	605	33	17 both
566	31	189	606	33	32
567	31	194	607	33	55
568	31	201	608	33	57 both
569	31	236 both	609	33	84 bottom two
570	31	287 last of 2	610	33	90
571	31	319 bottom 2	611	33	173 both
572	31	323	612	33	179 all
573	31	331 last of 2	613	33	235 all
574	31	345	614	33	255 both
575	31	395	615	33	271
576	31	424 first of 2	616	33	274
577	31	432 all 4	617	33	290 both
578	31	488	618	33	298
579	31	493	619	33	339
580	31	519	620	33	352-3 top
581	31	555 last of 2	621	33	372b whole page
582	32	24	622	33	391 both
583	32	37	623	33	393 all 4
584	32	59	624	33	404
585	32	61	625	34	17 both
586	32	131	626	34	54-5
587	32	146	627	34	79 second of 2
588	32	152 first of 2	628	34	95
589	32	166	629	34	111
590	32	188	630	34	161 second of 2

Illustration	Book	Page
631	34	166 both
632	34	181 first of 2
633	34	189
634	34	191
635	34	214
636	34	246
637	34	258
638	34	326
639	34	328
640	34	348 with shaded area
641	34	360
642	34	373
643	34	392 whole page
644	34	435
645	35	4 left
646	35	5 top 2
647	35	30 left
648	35	45
649	35	64
650	35	75
651	35	91 right
652	35	110 bottom
653	35	118-19 top
654	35	119 bottom 2
655	35	146 top right
656	35	160
657	35	165 both
658	35	188 top
659	35	188 middle
660	35	212 top
661	35	222
662	35	228 bottom
663	35	248
664	35	275 last of 2
665	35	292 both
666	35	316-17 top
667	35	326 left
668	35	340
669	35	344 top 2
670	35	358
671	35	375 right
672	36	26 last of 2
673	36	28 both
674	36	63
675	36	66
676	36	77
677	36	92 right
678	36	123 A-C
679	36	128
680	36	162
681	36	177 both
682	36	194
683	36	217 top
684	36	229 both
685	36	251
686	36	255
687	36	287
688	36	331
689	36	336
690	36	373
691	36	398 bottom
692	36	404
693	37	19
694	37	33
695	37	44
696	37	49 whole page
697	37	83
698	37	132
699	37	133
700	37	139
701	37	141
702	37	197
703	37	214 bottom
704	37	254
705	37	288
706	37	328 bottom
707	37	340 all 3
708	37	352 top
709	37	395 whole page
710	37	418

Illustration	Book	Page	Illustration	Book	Page
711	37	421	751	39	228 both
712	37	424-5	752	39	236
713	37	429 whole page	753	39	272-3 all
714	37	443	754	39	277 first of 2
715	38	8	755	39	289 top
716	38	38 left	756	39	329 both
717	38	61 right	757	39	339
718	38	64-5	758	39	359 both
719	38	104	759	39	371
720	38	118 top	760	39	377 last of 2
721	38	124 bottom	761	39	414
722	38	128	762	39	420 with shaded area
723	38	146	763	39	441 all 3
724	38	156	764	39	455 all 3
725	38	179 all 3	765	40	28
726	38	194	766	40	29 top
727	38	250 right	767	40	69
728	38	253	768	40	89
729	38	258-9	769	40	95 bottom
730	38	282 bottom	770	40	100-1
731	38	306 all 3	771	40	108
732	38	336	772	40	144 whole page
733	38	352-3	773	40	171
734	38	358	774	40	197
735	38	398	775	40	220-21
736	38	401 first of 2	776	40	236 bottom
737	39	6-7	777	40	244-45 all
738	39	39	778	40	264
739	39	57	779	40	268
740	39	73	780	40	285 last of 2
741	39	82 first of 2	781	40	291
742	39	110	782	40	334
743	39	119 both	783	40	336
744	39	144-VIII	784	40	337 all 3
745	39	154-5	785	40	379
746	39	186	786	40	405 right
747	39	187	787	40	409 all 5
748	39	224-V first of 2			
749	39	224-XIV first of 2			
750	39	225			

APPENDIX F

TAXONOMY OF PHYSICAL PROPERTIES OF INSTRUCTIONAL ILLUSTRATIONS

The following information deals with the development of a taxonomy or way of classifying pictures (or pictorial units) according to their physical properties. The development of this taxonomy constituted one part of a USOE-supported research project dealing with a survey of types of instructional illustrations occurring in textbooks.

While it is expected that this taxonomy will be useful for a wide variety of pictorial materials, it was designed for the specific sample of pictorial units selected for this study. The sample was drawn from 10 eighth-grade textbooks in each of four different subject-matter areas (math, science, English, and history). Pictorial units were identified by means of the pictorial, verbal, and design elements that make up the pages of these textbooks.

Pictorial elements were defined as configurations of line, dot, or area, and any combination of these three that resemble events or objects (persons, places, and/or things), either as perceived or as generally conceived. Also considered as pictorial elements were such border line cases as: number lines and geometric figures found in math books (Figure 1, A and B); structural formulae found in chemistry (C); and curves, graphs, and time lines found in history and science books (D, E, F).

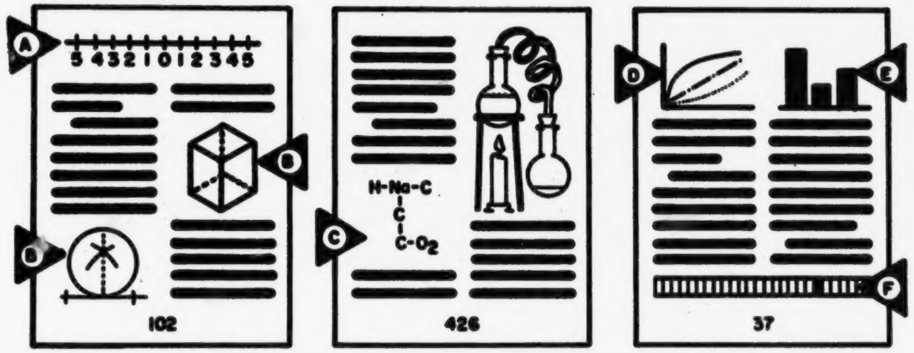


FIGURE 1. EXAMPLES OF PICTORIAL ELEMENTS

Verbal elements were defined as configurations of line, dot, or area and any combination of these three that resemble alphabetical or numerical symbols. Included in the category of verbal elements were such border line cases as: pictorial lettering, such as Chinese sign-writing and Egyptian hieroglyphics; punctuation marks; and musical and scientific notation (as long as they are arbitrary). See Figure 2.

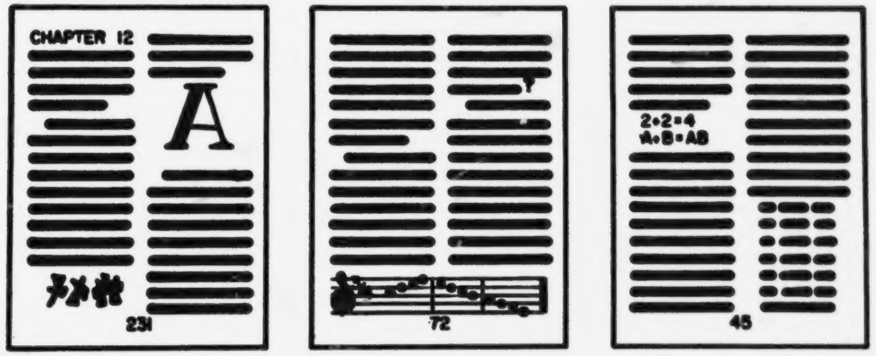


FIGURE 2. EXAMPLES OF VERBAL ELEMENTS

Design elements were defined as configurations of line, dot, or area and any combination of these three that did not meet the definition of either the pictorial or verbal elements. These design elements appear to modify or direct attention to pictorial or verbal elements. The category of design elements included such things as: lines around or between areas (Figure 3, B and F); arrows (C); and colored or textured areas under pictorial or verbal elements (E).

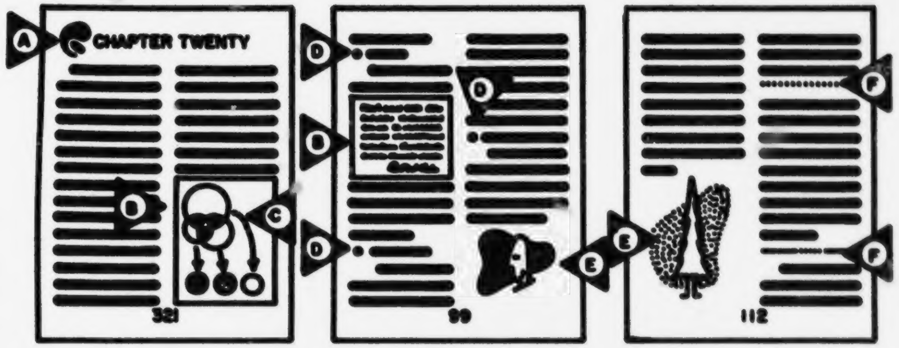


FIGURE 3. EXAMPLES OF DESIGN ELEMENTS

The pages that were selected for testing this taxonomy contained pictorial elements alone or pictorial elements in combination with verbal and/or design elements. See Figure 4.

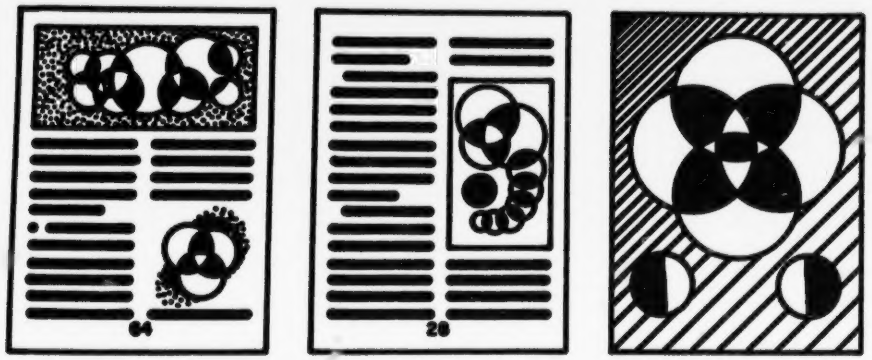


FIGURE 4. EXAMPLES OF PAGES CONTAINING PICTORIAL ELEMENTS ALONE OR IN COMBINATION WITH VERBAL AND/OR DESIGN ELEMENTS

INSTRUCTION FOR USING THE TAXONOMY

Figure 5 shows the four general classes of verbal combinations: text (A); captions (B); labels and legends (C); and titles (D).

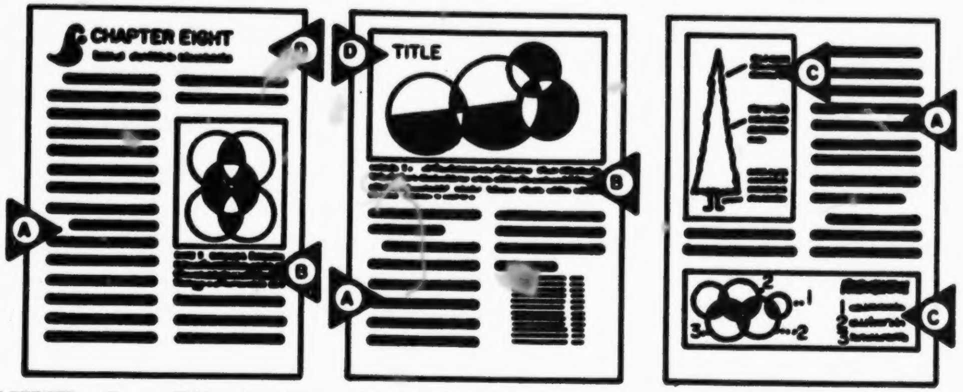


FIGURE 5. EXAMPLES OF THE FOUR COMBINATIONS OF VERBAL ELEMENTS

To use the taxonomy, you should never consider text and caption as part of the pictorial units. Consider labels, legends and titles only when they fall within the "frame" of the pictorial unit. (See Scale 2, Determining the Framing of the Pictorial Unit)

You are to consider all verbal material that is inherently a part of the picture, e.g., the title on a pictured book, written material on a pictured blackboard, registration numbers on a pictured airplane, etc.

The number of physical properties of pictures are almost unlimited; however, the designers of this taxonomy selected eleven. The criteria for selection were physical properties that would: (1) relate to the possible educational objectives of the picture; (2) help to differentiate between pictures; and (3) provide a better understanding of the over-all design and potential use of pictures. The eleven physical properties are as follows:

1. area
2. framing
3. configuration
4. position
5. elements
6. chroma
7. achroma
8. encoding medium
9. encoding style
10. information
11. unification

Each of these eleven physical properties became a separate scale with each scale being divided into points. See Figure 6 for an example of one of these scales.

Point	Description
1	Square
2	Horizontal rectangle
3	Vertical rectangle
4	Irregular rectangle
5	Circular and ellipsoid
6	Free-form, amoeboid
7	Other shapes
9	Mixed shapes

FIGURE 6. THE SCALE FOR THE CONFIGURATION OR SHAPE OF THE PICTORIAL UNIT

Thus, to use the scales in this taxonomy, you should examine the picture that you are classifying and find that point on the scale that most nearly represents the specific picture. Note that in Figure 7, the numbers 1-7 refer to the separate points on the scale shown in Figure 6.

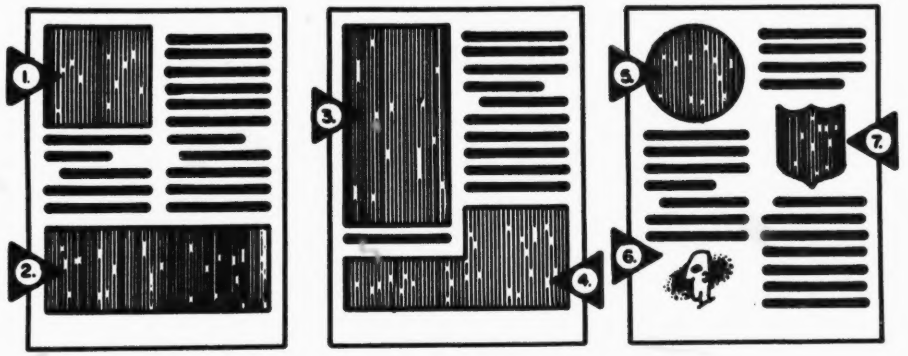


FIGURE 7. CODED EXAMPLES FOR SCALE 3

When you have judged a picture by using the eleven scales in the taxonomy, you will have assigned to that picture an eleven-unit code number, and each of the individual units in the number code will represent your selection of a point on one of the eleven scales. Note that the code unit for Scale 4 is a combination of letters of the alphabet rather than a single numeral.

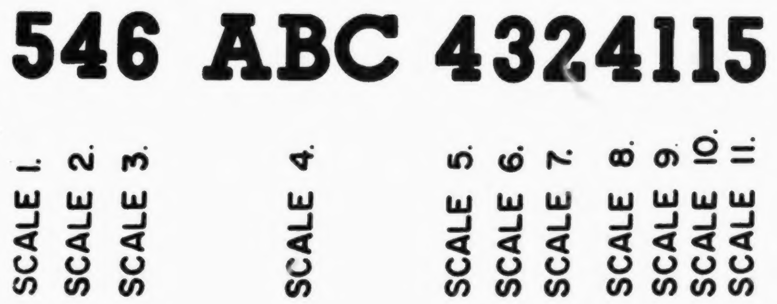


FIGURE 8. SAMPLE OF THE ELEVEN-UNIT CODE NUMBER

The eleven-unit code number shown in Figure 8 is interpreted as follows: the 5 indicates that you selected Point 5 on Scale 1 (area); the 4 indicates that you selected Point 4 on Scale 2 (framing); the 6 indicates that you selected Point 6 on Scale 3 (shape); and the ABC indicates that you selected this value on Scale 4 (position). The remaining seven units in the code number represent the selection of individual points on Scales 5 through 11.

Your judging task will be to assign a code number to a sample of pictures by using the eleven scales in this taxonomy. Pages 4 - 25 describe and exemplify the eleven scales. Read the information on these pages carefully to familiarize yourself with the scales. On page 2 you will find, for easy reference, a listing of the 11 scales and the various points on each scale and also two sample visuals that have already been coded. Check the code number to test your understanding of the scales as a last step before you attempt to classify a sample of pictures.

SCALE 1: Determining the Area of the Pictorial Unit

The first physical property to be classified is the area or size of the picture.

Area or size of picture is measured by the use of a transparent grid divided into square inches. Place the transparent grid over the illustration to be measured. Line up the top edge and the left-hand edge of the grid with the top edge and the left-hand edge of the picture. See Figure 9.

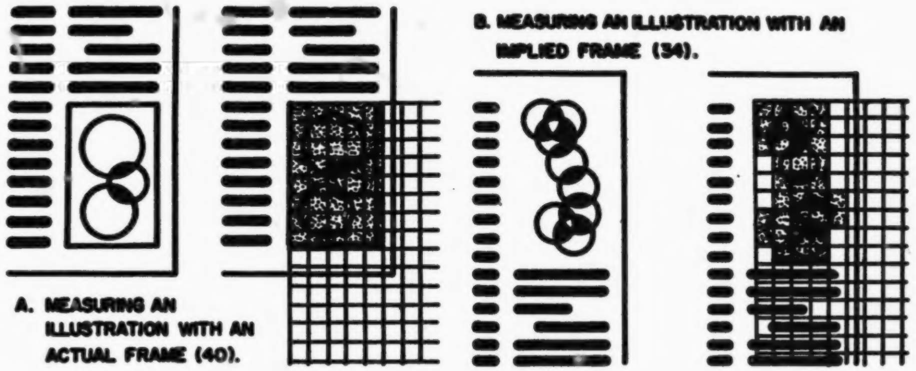

A. MEASURING AN ILLUSTRATION WITH AN ACTUAL FRAME (40).
B. MEASURING AN ILLUSTRATION WITH AN IMPLIED FRAME (34).

FIGURE 9. ALIGNING GRID FOR DETERMINING AREA (SIZE) OF THE PICTURE (ACTUAL FRAMING, A) AND (IMPLIED FRAMING, B)

Count the number of squares on the grid that include any portion of the picture. If the grid does not cover the entire picture, as in a two-page pictorial unit, first count the number of squares on the grid that include any portion of the picture for the left-hand page; then, count the number of squares on the grid for the right-hand page; then add the two. See Figure 10.

Each square on the grid is one square inch. By counting the number of squares that include portions of the picture, you will determine the number of square inches it covers. From Scale 1 (Determining the Area of the Pictorial Unit), select the point that contains the number of square inches you have counted.

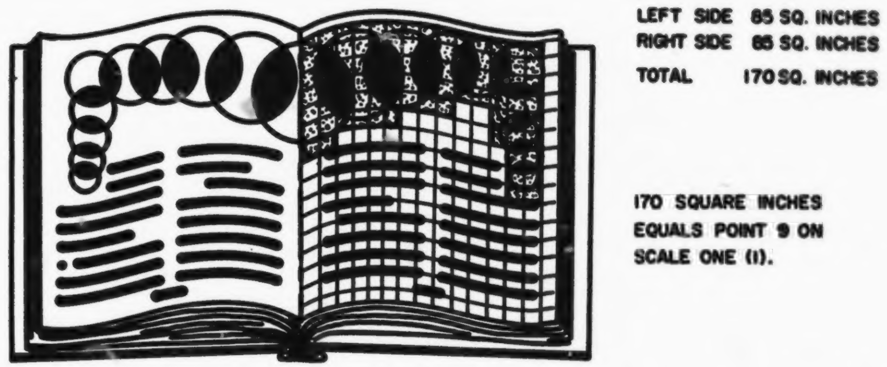

LEFT SIDE 85 SQ. INCHES
RIGHT SIDE 85 SQ. INCHES
TOTAL 170 SQ. INCHES
170 SQUARE INCHES EQUALS POINT 9 ON SCALE ONE (I).

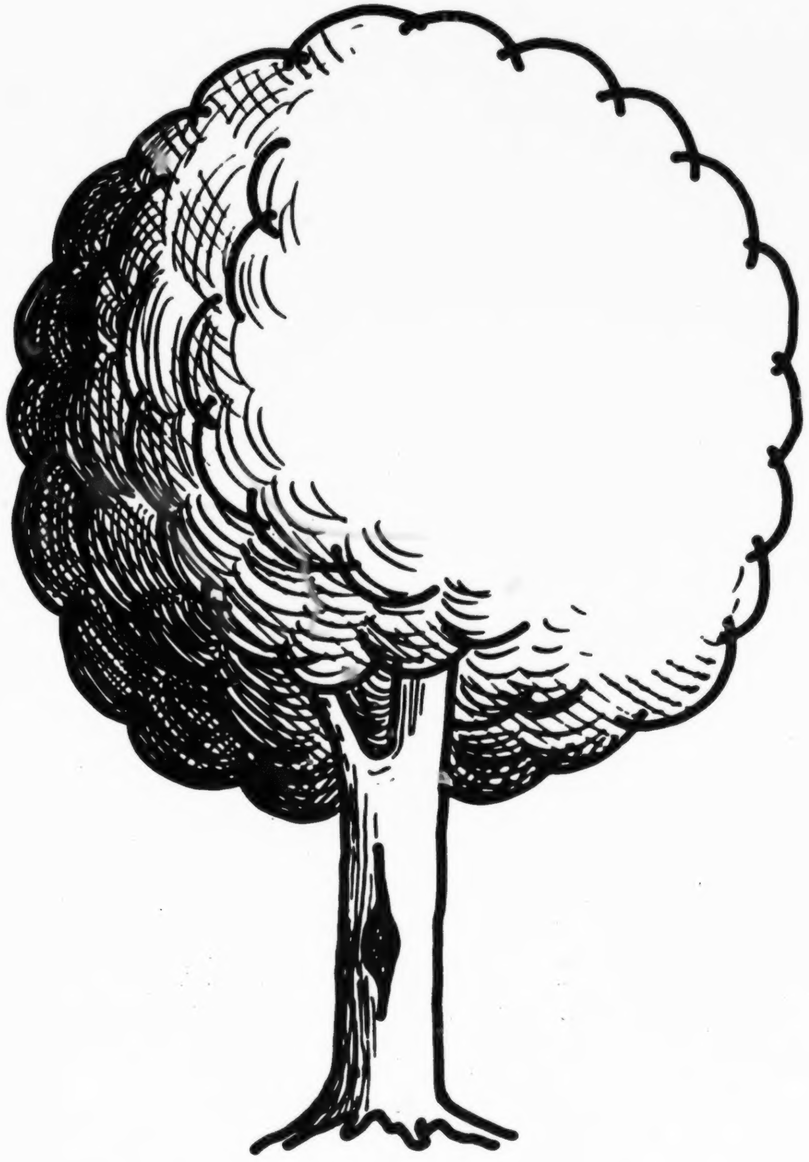
FIGURE 10. DETERMINING AREA OF A TWO-PAGE PICTORIAL UNIT

For example, if your counting results in 21 square inches, you would select Point 5 on Scale 1 (18-25 square inches). Therefore, 5 is the first unit in the code number for this picture.

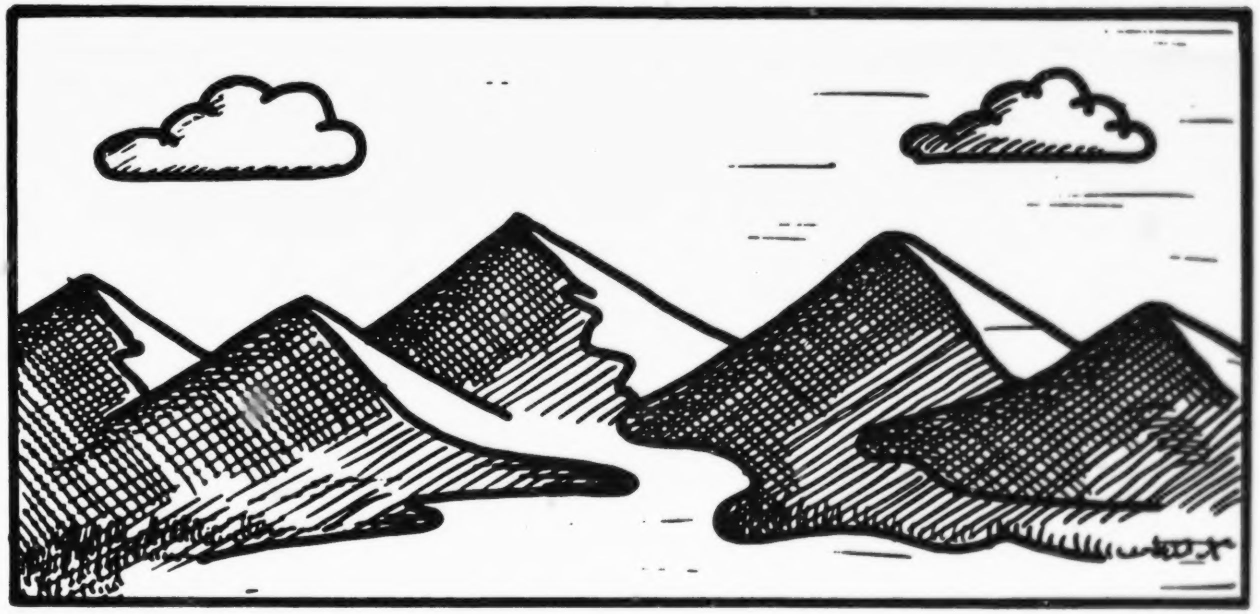
SCALE 1: Determining the Area of the Pictorial Unit

Point	No. of Square Inches
1	0-4
2	5-8
3	9-12
4	13-17
5	18-25
6	26-40
7	41-80
8	81-110
9	111-140+

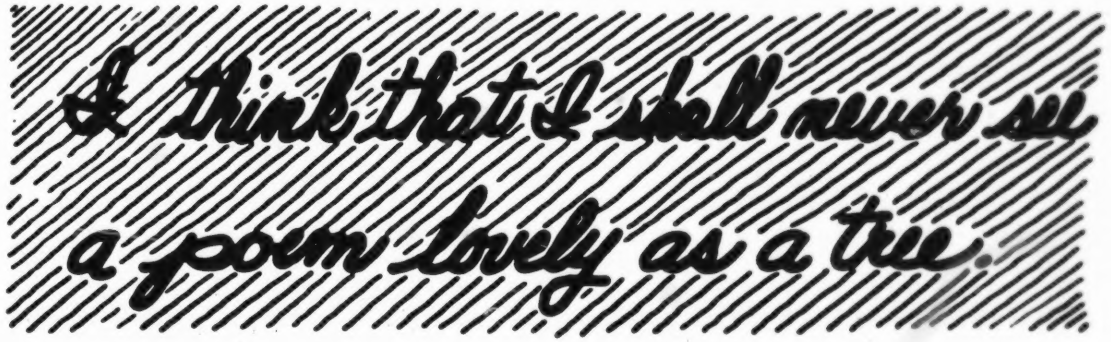
D



AREA: 17 SQUARE INCHES



AREA: 18 SQUARE INCHES


I think that I shall never see
a poem lovely as a tree.

AREA: 10 SQUARE INCHES

FIGURE 11. PICTORIAL UNITS TO BE MEASURED WITH THE GRID TO PRACTICE MEASURING TECHNIQUES

SCALE 2: Determining the Framing of the Pictorial Unit

The second physical property to be classified is the type of framing that is used to contain the picture. Framing is defined as that technique that contains or combines pictorial elements into a unitary whole. There are two classes of framing: (1) actual, and (2) implied. In actual framing, distinct lines or edges separate the picture from the remainder of the page. See Figure 12.

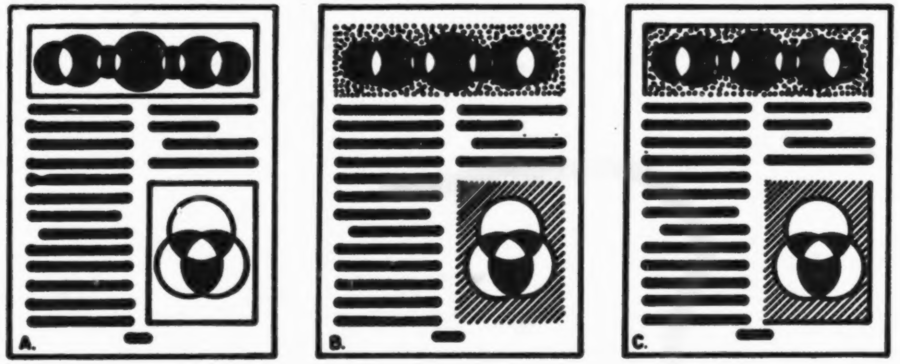


FIGURE 12. EXAMPLES OF ACTUAL FRAMES: LINE (A), EDGE (B), COMBINATION (C)

In implied framing there is no distinct separation of the background of the picture from the page color upon which it is printed, i.e., the picture ground and page are the same. The edge of the pictured objects or a design element are all that separate the picture from the page. See Figure 13.

A picture is said to "bleed" when the edge of the picture corresponds either to the edge of the page or to the center fold of the page. Bleed is a special case of framing and is not to be confused with actual framing. Pictures may bleed on one, two, three, or even on all four sides. See Figure 14.

Select from Scale 2 below that point which most nearly corresponds to the type of framing evident in the picture you are classifying.

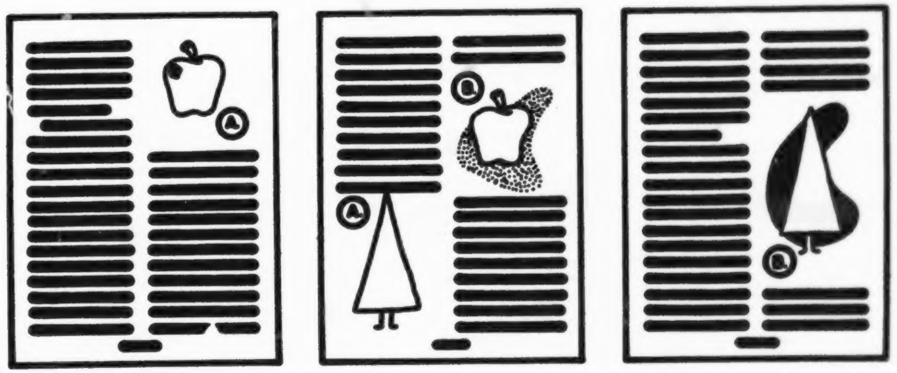


FIGURE 13. EXAMPLES OF IMPLIED FRAMES WITHOUT DESIGN ELEMENTS (A), WITH DESIGN ELEMENTS (B)

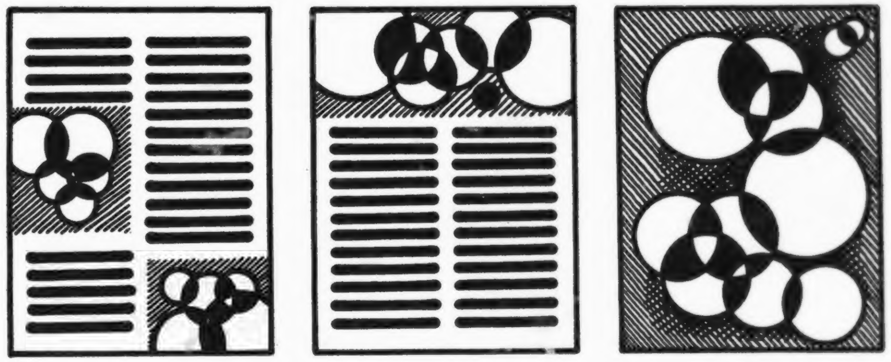
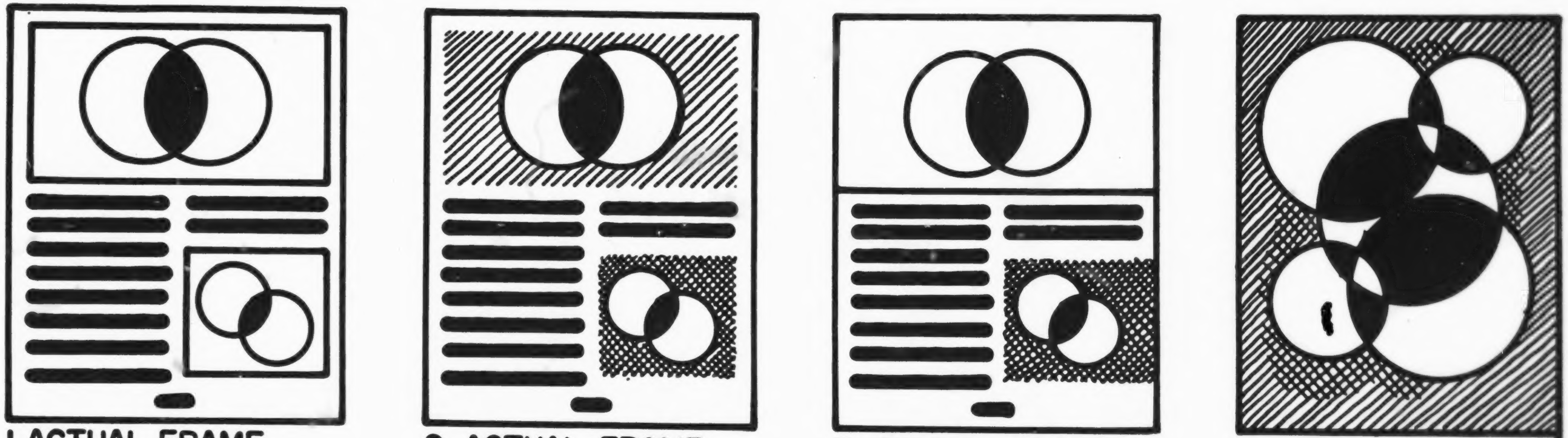


FIGURE 14. EXAMPLES OF VARIOUS TYPES OF BLEED

SCALE 2: Determining the Framing of the Pictorial Unit

Point	Description
1	Actual frame...distinct line on four sides
2	Actual frame...abrupt edge on four sides
3	Actual frame...distinct line or abrupt edge but with bleed on 1-3 sides
4	Bleed on all four sides of the picture
5	Combinations of actual and implied frames
6	Implied frames but with bleed on 1-3 sides
7	Implied frame on four sides
9	Mixed framing (framing that doesn't fit into any other point on this scale)

F

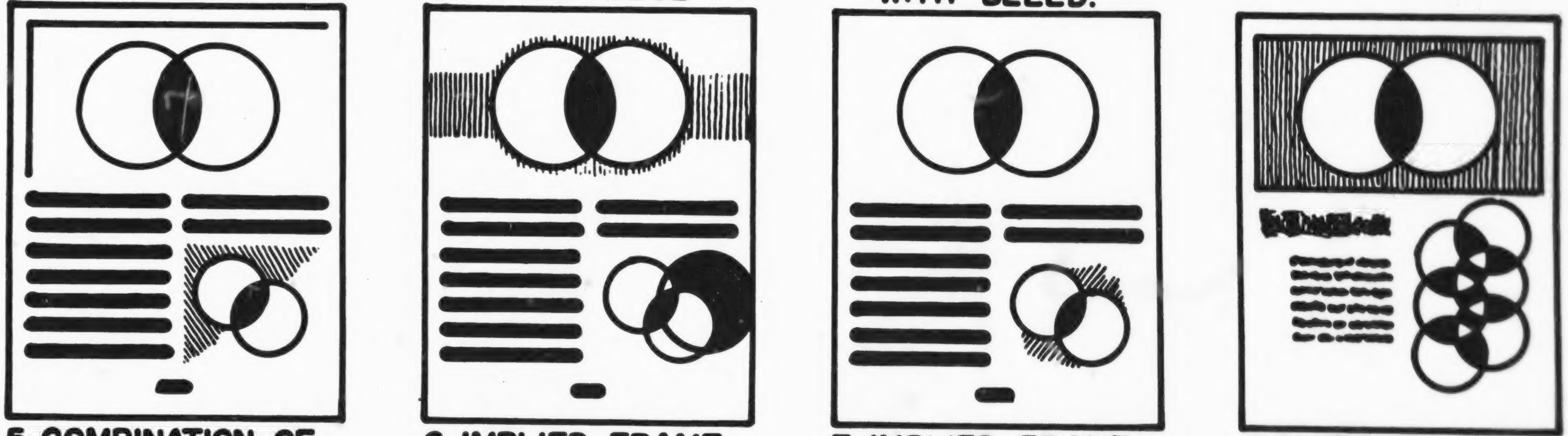


1. ACTUAL FRAME DISTINCT LINE.

2. ACTUAL FRAME ABRUPT EDGE

3. ACTUAL FRAME WITH BLEED.

4. BLEED FOUR SIDES



5. COMBINATION OF ACTUAL & IMPLIED.

6. IMPLIED FRAME WITH BLEED.

7. IMPLIED FRAME

9. MIXED FRAMING.

FIGURE 15. EXAMPLES OF THE POINTS ON THE SECOND SCALE "DETERMINING THE FRAMING OF THE PICTORIAL UNIT"

SCALE 3: Determining the Configuration of the Pictorial Unit

The third physical property to be classified is the configuration or shape of the pictorial unit. Configuration is defined as the basic shape or outline and is dependent upon the actual or implied frame that contains the basic shape. Note the configurations in Figure 16 A - Square, B - Verticle Rectangle, C - Horizontal Rectangle, D - Irregular Rectangle, and E - Circular.

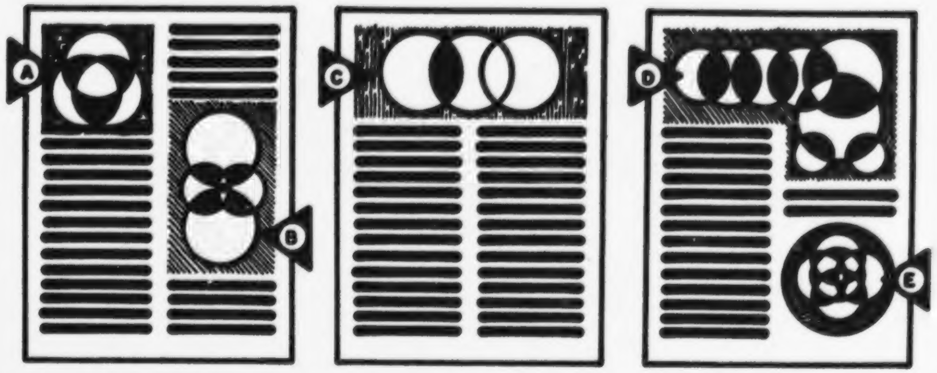


FIGURE 16. SHAPES DETERMINED BY ACTUAL FRAMES

When the framing is implied, the determination of the configuration of the picture becomes more difficult. In Figure 17, a series of pictures are shown that have implied frames. Note that in A there is a design element associated with the apple, while in B the perimeter of the apple is all that separates the image from the page. Example A is classed Point 6 on Scale 3, while B is classed as Point 7. Where design "ground" is present in instances of implied frames, use Point 6. However, when the object is presented in limbo, (without any background other than the page) use Point 7.

When an picture is composed of more than one "separable" unit and these units have different shapes, use Point 9 (mixed shapes). Point 9 may also be used to classify any picture that does not appear to be described by Point 1-7. See Figure 18.

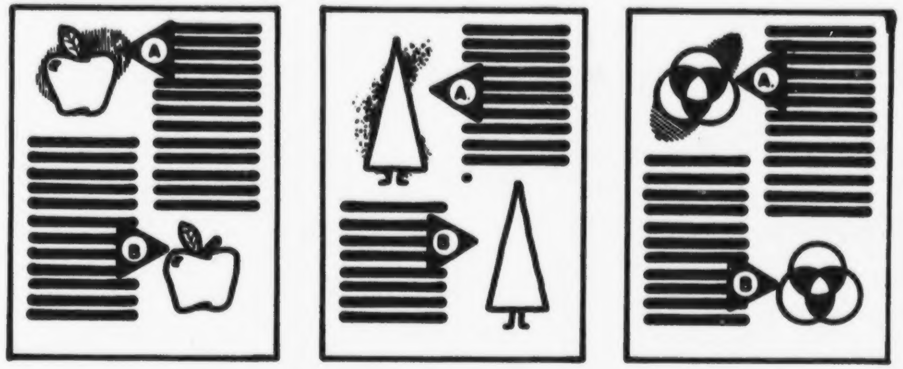


FIGURE 17. SHAPES DETERMINED BY IMPLIED FRAMES

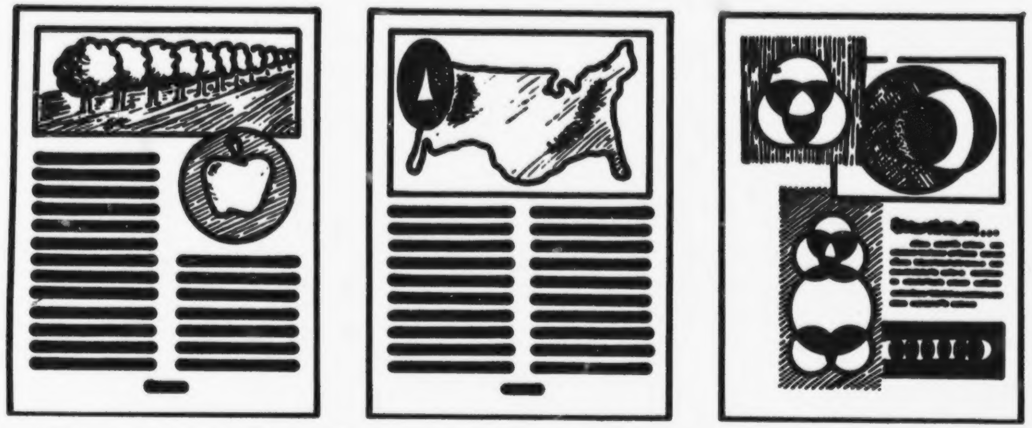
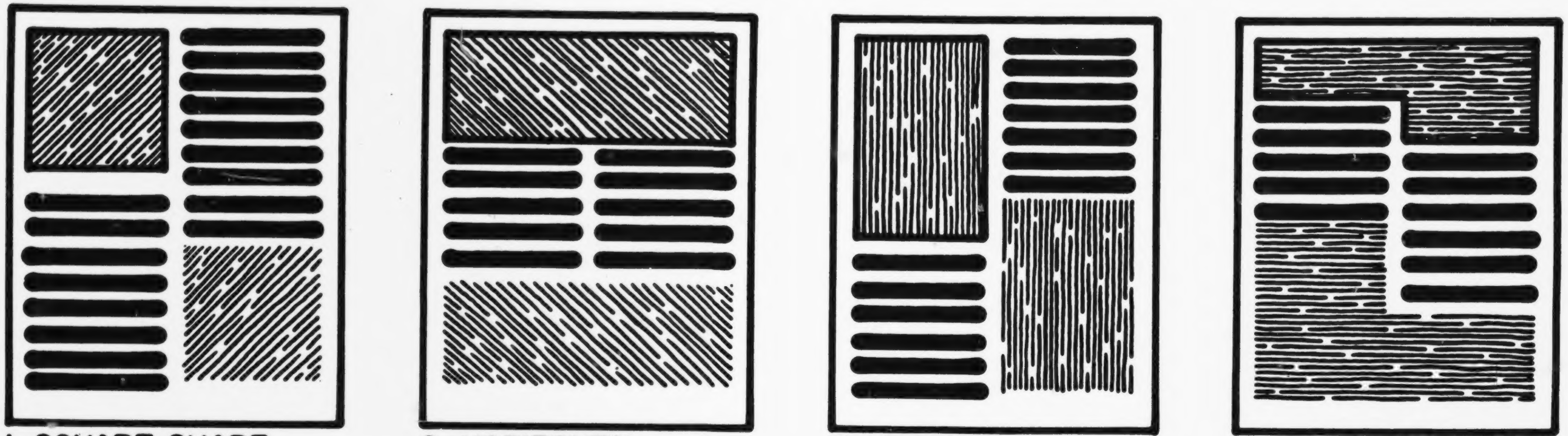


FIGURE 18. EXAMPLES OF MIXED SHAPES

SCALE 3: Determining the Configuration of the Pictorial Unit

Point	Description
1	Square
2	Horizontal rectangle
3	Vertical rectangle
4	Irregular rectangle
5	Circular and ellipsoid
6	Free-form, amoeboid
7	Other shapes
9	Mixed shapes

H

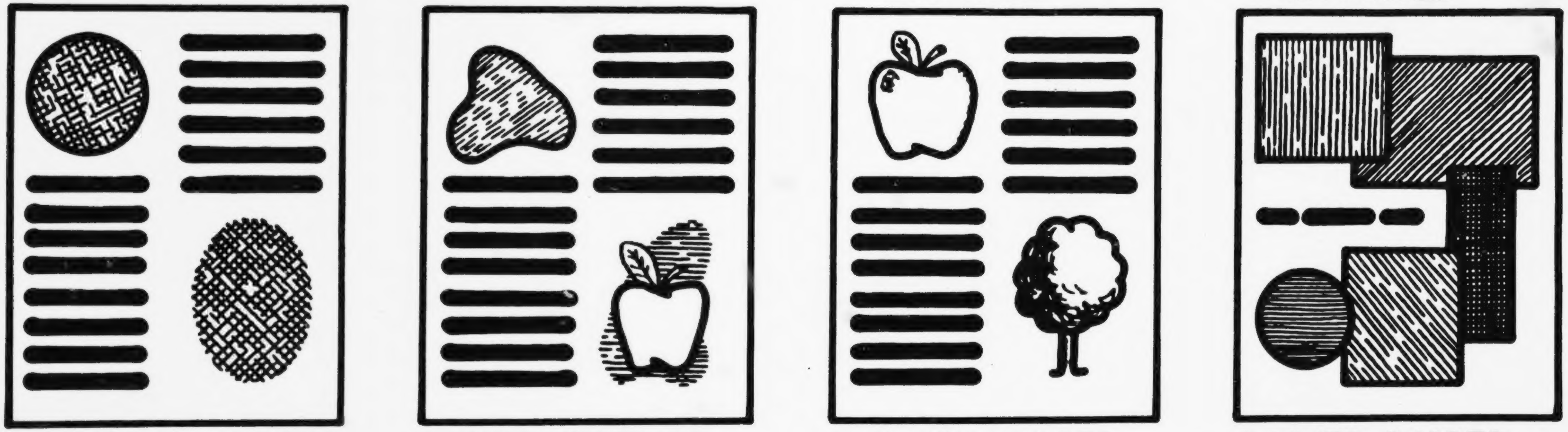


1. SQUARE SHAPE

2. HORIZONTAL RECTANGLE

3. VERTICAL RECTANGLE

4. IRREGULAR RECTANGLE



5. CIRCULAR SHAPES

6. FREE FORM OR AMOEBOID SHAPES

7. OTHER SHAPES

9. MIXED SHAPES

FIGURE 19. EXAMPLES OF POINTS ON THE THIRD SCALE "DETERMINING THE CONFIGURATION OF THE PICTORIAL UNIT"

SCALE 4: Determining the Position of the Pictorial Unit

The fourth physical property to be classified as the position or placement of the picture on the page. To determine picture placement you must imagine a grid superimposed over the page. See Figure 20.

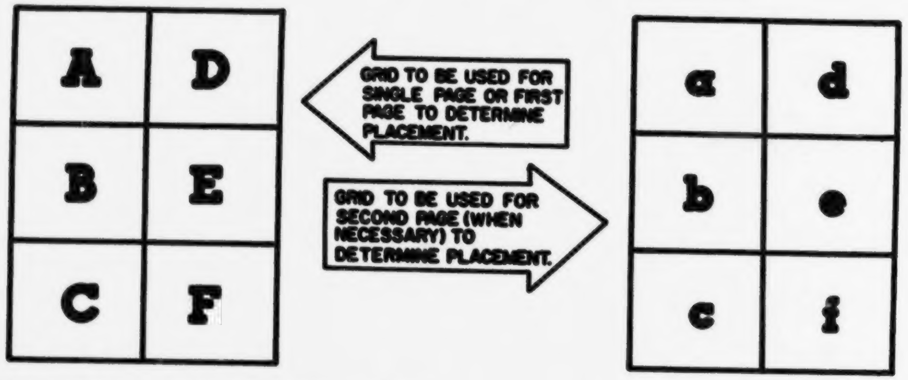

A
D
B
E
C
F
GRID TO BE USED FOR SINGLE PAGE OR FIRST PAGE TO DETERMINE PLACEMENT.
GRID TO BE USED FOR SECOND PAGE (WHEN NECESSARY) TO DETERMINE PLACEMENT.
a
d
b
e
c
f

FIGURE 20. IMAGINARY GRID

Note that the grid is superimposed over the entire page, not just the picture. Placement of the center line of the imaginary grid should correspond to the center margin on any page that has a two-column text arrangement. See Figure 21-1. Center the grid in the same way even though the center margin on the page is off-center (either to the right or left). See Figure 21-2. Where the page does not have a center margin (See Figure 21-3), center the imaginary grid over the entire page.

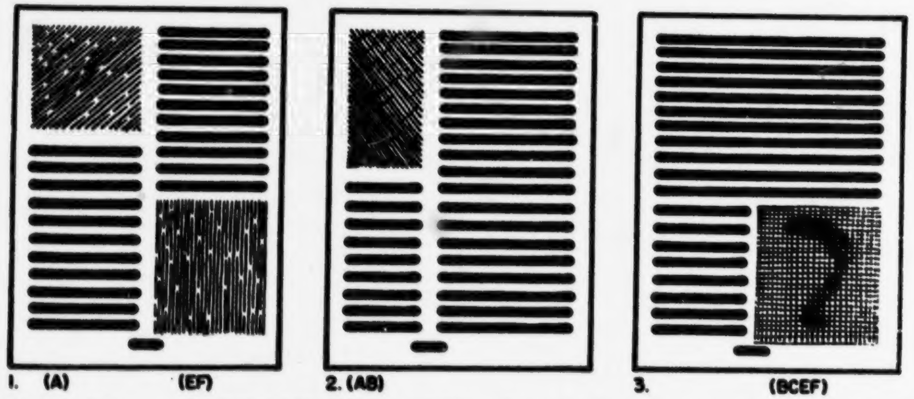

1. (A)
(EF)
2. (AB)
3.
(BCEF)

FIGURE 21. POSITIONING GRID ON VARIOUS PAGE FORMATS

J

Note in Figure 22, showing a two-page spread, the use of capital letters for the left-hand page and small letters for the right-hand page. Small letters are used only when classifying a two-page spread.

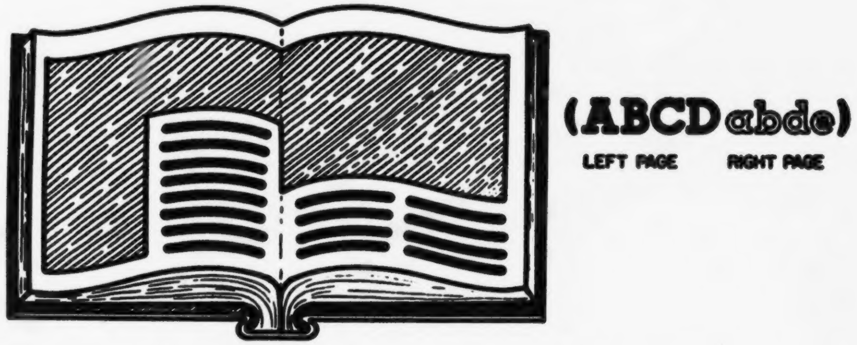

(ABCDabde)
LEFT PAGE
RIGHT PAGE

FIGURE 22. CLASSIFYING A TWO-PAGE SPREAD

When a picture entirely covers a single page, you should use the letter Z to classify its position rather than ABCDEF. See Figure 23.

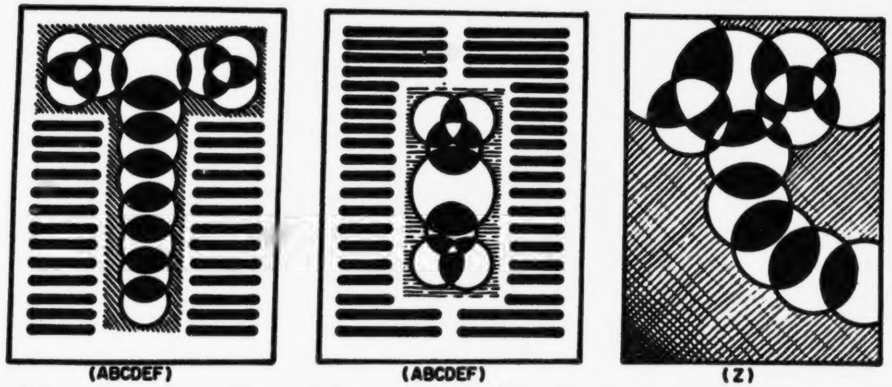

(ABCDEF)
(ABCDEF)
(Z)

FIGURE 23. COMPARISON OF CLASSES ABCDEF AND Z

Note that this scale is the only one that has a multi-alphabetical code unit rather than a single numerical code unit.

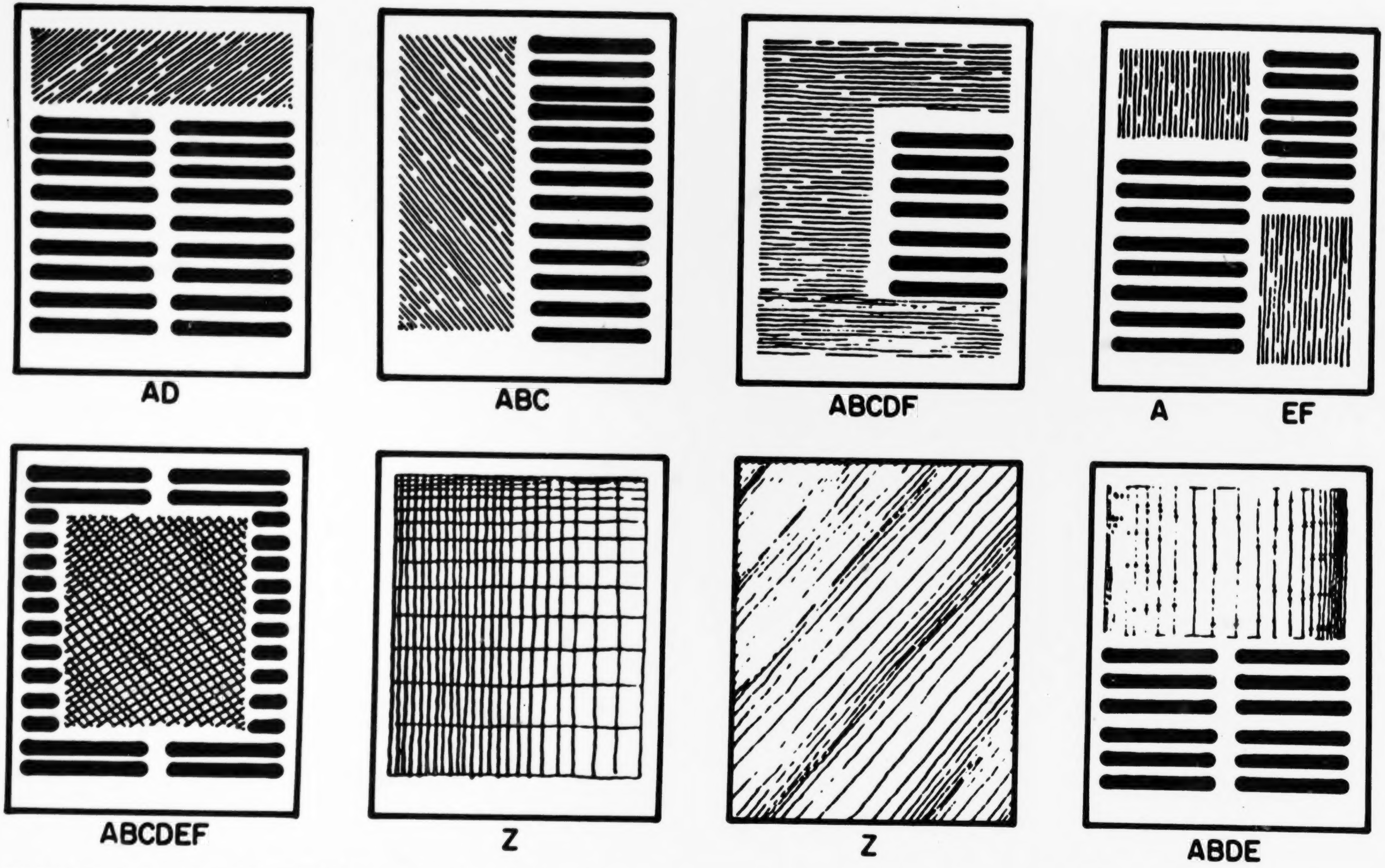

AD
ABC
ABCDF
A
EF
ABCDEF
Z
Z
ABDE

FIGURE 24. CODED EXAMPLES OF SOME OF THE POSSIBLE POINTS ON THE FOURTH SCALE "DETERMINING THE POSITION OF THE PICTORIAL UNIT ON THE PAGE"

K

SCALE 5: Determining the Pictorial, Verbal, and/or Design Elements in the Pictorial Unit

The fifth physical property to be classified is the elements present in the illustration (pictorial, verbal, and/or design elements). Pictorial elements were defined as configurations of line, dot, or area, and any combination of these three that resemble events or objects (persons, places, and/or things), either as perceived or as generally conceived. Also considered as pictorial elements were such border line cases as shown in Figure 25.

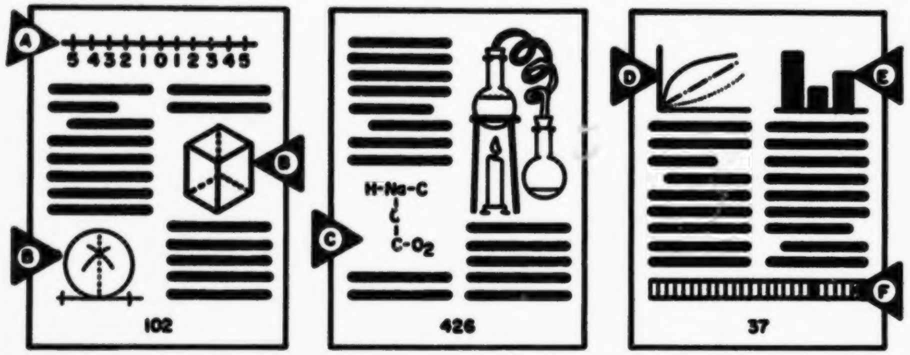


FIGURE 25. BORDER LINE PICTORIAL ELEMENTS

Verbal elements were defined as configurations of line, dot, or area and any combination of these three that resemble alphabetical or numerical symbols. Included in the category of verbal elements were such border line cases as shown in Figure 26.

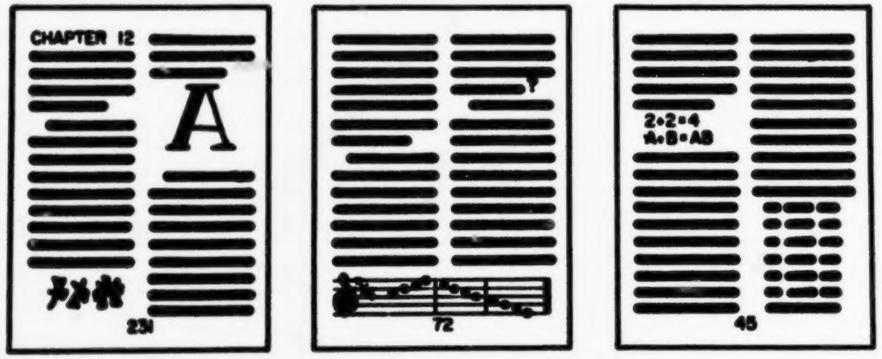


FIGURE 26. BORDER LINE VERBAL ELEMENTS

L

Design elements were defined as configurations of line, dot, or area and any combination of these three that did not meet the definition of either the pictorial or verbal elements. The category of design elements included such things as shown in Figure 27.

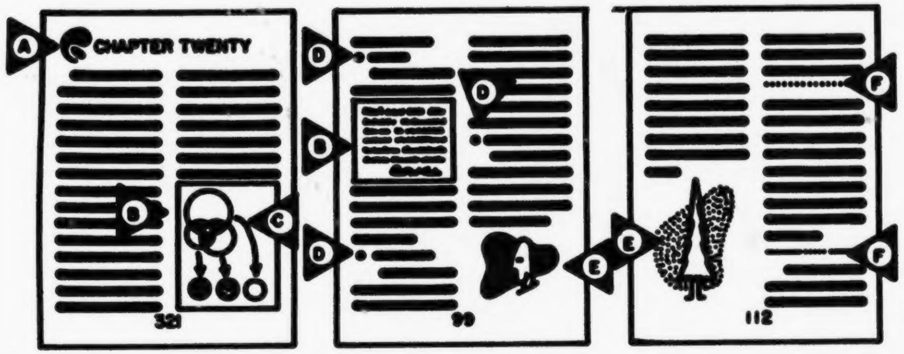


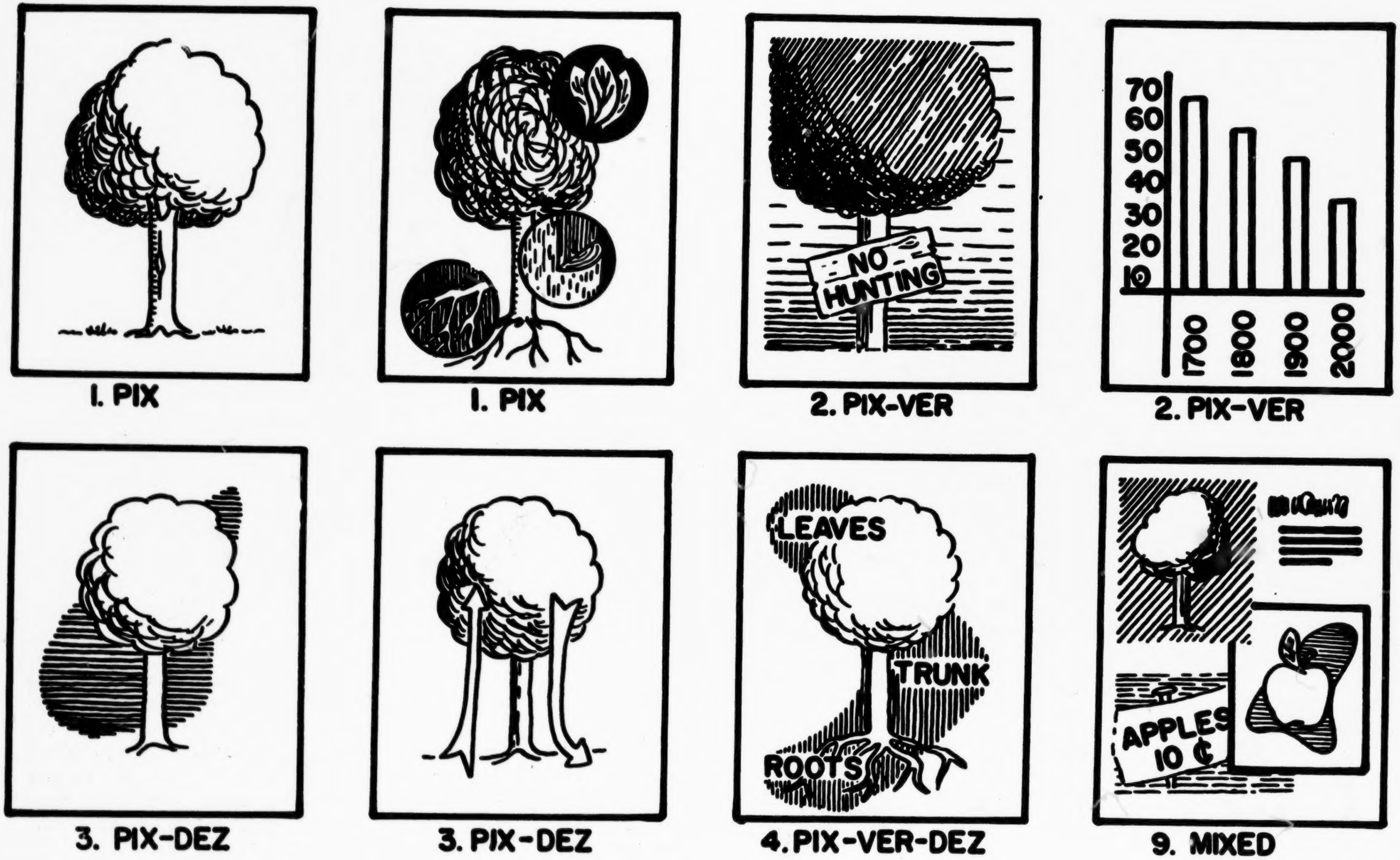
FIGURE 27. DESIGN ELEMENTS

When the pictorial unit is composed of a number of separable pictures that fall at different points on the scale, use Point 9. Point 9 may also be used for those pictorial units you feel cannot be classified under Points 1-4. Try and use Point 9 sparingly.

Remember that only verbal material that appears inside the frame (implied or actual) of the pictorial unit are to be considered in this scale.

SCALE 5: Determining the Pictorial, Verbal, and/or Design Elements of the Pictorial Unit

Point	Description
1	Pictorial elements only
2	Combination of pictorial and verbal elements
3	Combination of pictorial and design elements
4	Combination of pictorial, verbal, and design elements
9	Mixed



NO HUNTING
70
60
50
40
30
20
10
1700
1800
1900
2000
LEAVES
TRUNK
ROOTS
APPLES 10 ¢

1. PIX 1. PIX 2. PIX-VER 2. PIX-VER

3. PIX-DEZ 3. PIX-DEZ 4. PIX-VER-DEZ 9. MIXED

FIGURE 28. EXAMPLES OF THE POINTS ON THE FIFTH SCALE "DETERMINING THE PICTORIAL, VERBAL, AND/OR DESIGN ELEMENTS OF THE PICTORIAL UNIT"

SCALE 6: Determining the Chromatic Type of the Pictorial Unit

The sixth physical property to be classified is the chromatic types of the picture.

The term "chromatic" is defined as those colors comprising the visible spectrum (violet through red). Note that the term "chromatic" excludes black, white, and all greys. Thus, for chromatic typing you are to consider the number of colors present in the picture. The examples in Figure 29 are classed as (a) no-color (non-chromatic), (b) one-color (mono-chromatic), and (c) two-color (duo-chromatic).

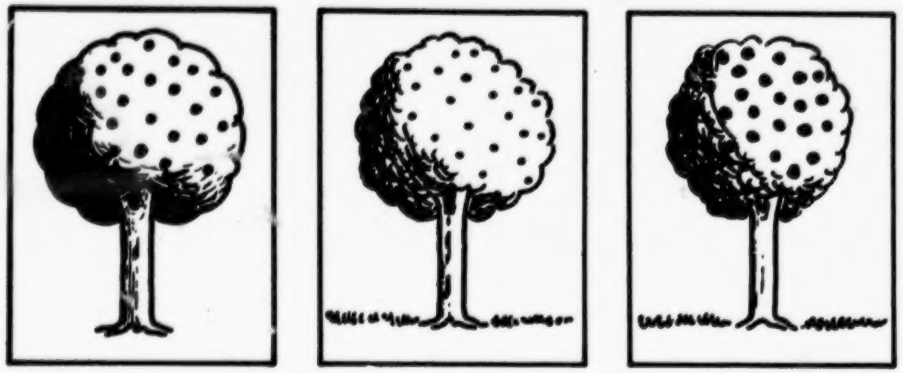


FIGURE 29. EXAMPLES OF PICTURES CLASSIFIED ACCORDING TO THEIR CHROMATIC TYPE

Note in Figure 30 that only major color differences are considered -- not shades of the same color. For example, when a picture contains three different shades of the major color, (such as red) and no other color, it is still classed as one-color (mono-chromatic). Only combinations of major colors, such as red, yellow, blue, brown, green, etc., are classed as more than one color.

Note Point 5 and Point 6 of this scale are designated as a poly-chromatic and a full-chromatic. The poly-chromatic designation (Point 5) is intended for those pictures that contain more than three major colors but are not perceived as full-color.

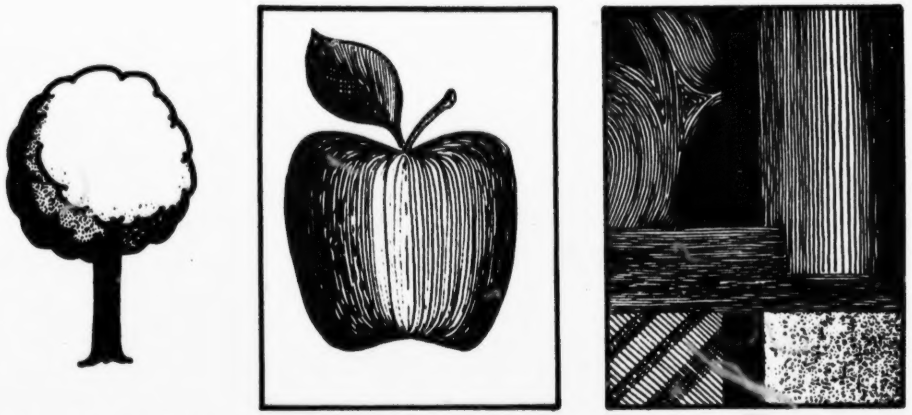


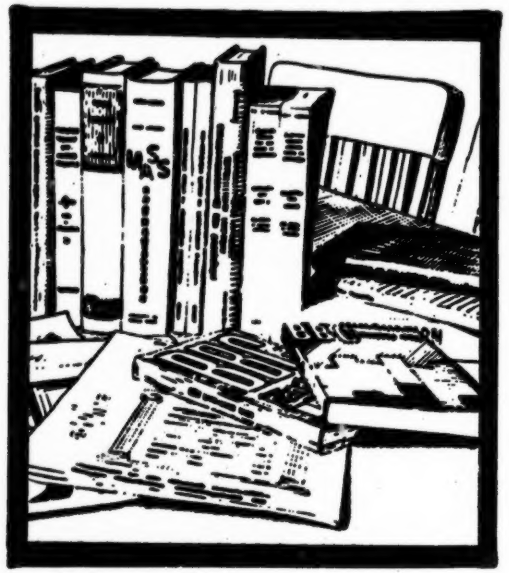
FIGURE 30. MONO-CHROMATIC PICTURES

Note also the mixed-chromatic point (Point 9). When the picture is composed of a number of separable units that fall at different points on the scale, use Point 9. Point 9 may also be used for those pictures you feel cannot be classified under Points 1-6. Try to use Point 9 sparingly.

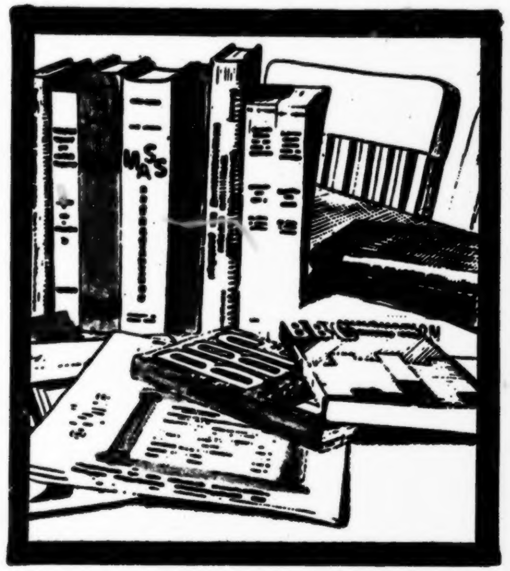
SCALE 6: Determining the Chromatic Type of the Pictorial Unit

Point	Description
1	Non-chromatic (no color)
2	Mono-chromatic (one color)
3	Duo-chromatic (two colors)
4	Tri-chromatic (three colors)
5	Poly-chromatic (more than three colors but not full color)
6	Full-chromatic (appearing like a full color photo or realistic drawing)
9	Mixed-chromatic

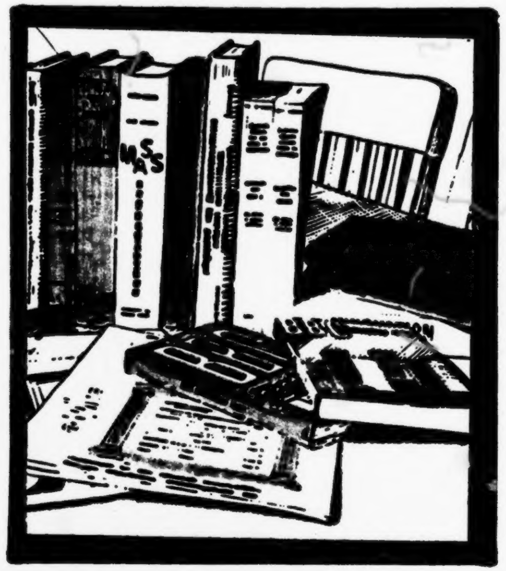
N



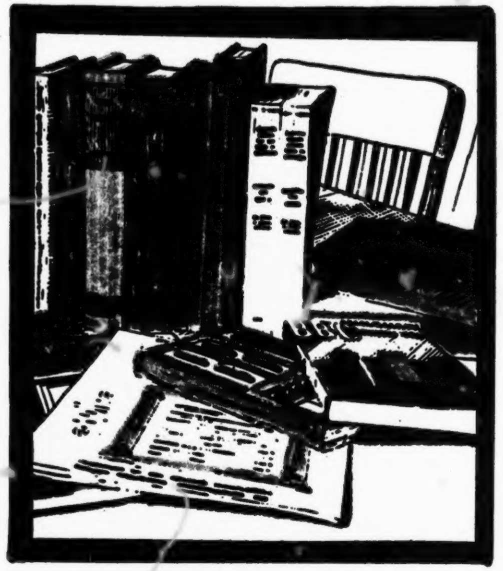
1. NON-CHROMATIC



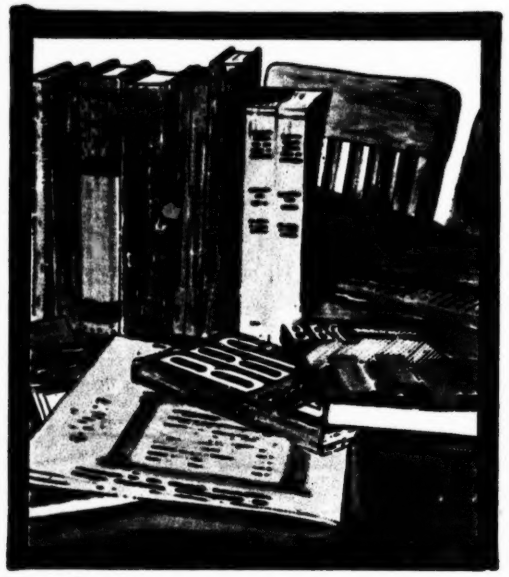
2. MONO-CHROMATIC



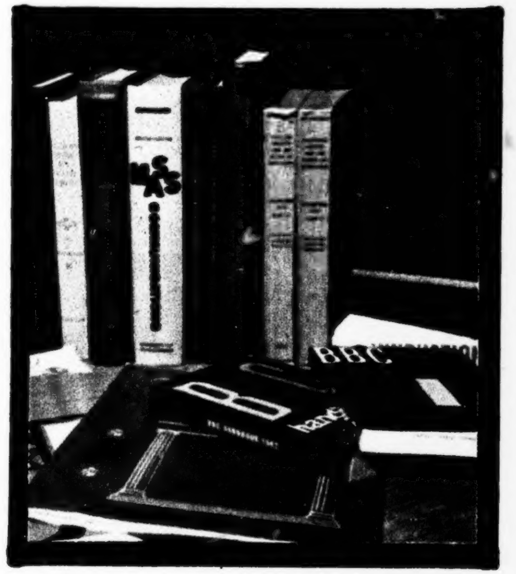
3. DUO-CHROMATIC



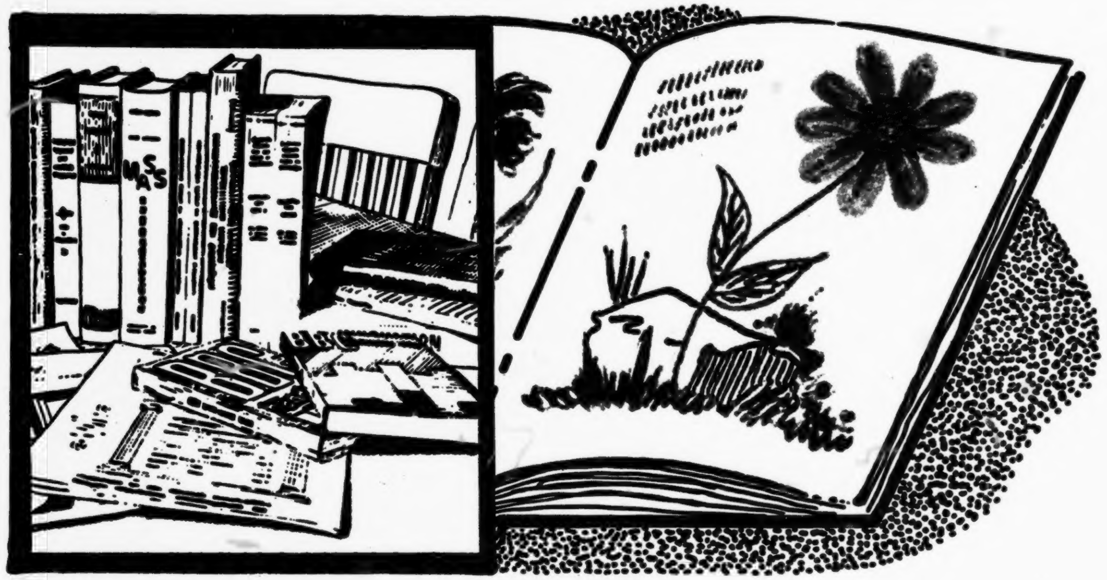
4. TRI-CHROMATIC



5. POLY-CHROMATIC



6. FULL-CHROMATIC



9. MIXED-CHROMATIC

FIGURE 31. EXAMPLES OF POINTS ON THE SIXTH SCALE "DETERMINING THE CHROMATIC TYPE OF THE PICTORIAL UNIT".

SCALE 7: Determining the Achromatic Type of the Pictorial Unit

The seventh physical property to be classified is to determine the achromatic types of the picture.

The term "achromatic" is defined as representing all points (shades) on a black to white continuum. However, certain exceptions must be considered.

White is the normal color of the page on which text and pictures are printed. In printing, white is created by the absence of any ink. Therefore, Scale 7 omits pure white. An illustration that is made up of black lines containing white areas is considered mono-achromatic (Point 1). Also in printing there are usually no "grey" inks; the illusion of grey is achieved by reducing black to grey through a screening process. Ignore this fact and classify only what you see. If the image appears to have greys in it, treat it as such. See Figure 32.

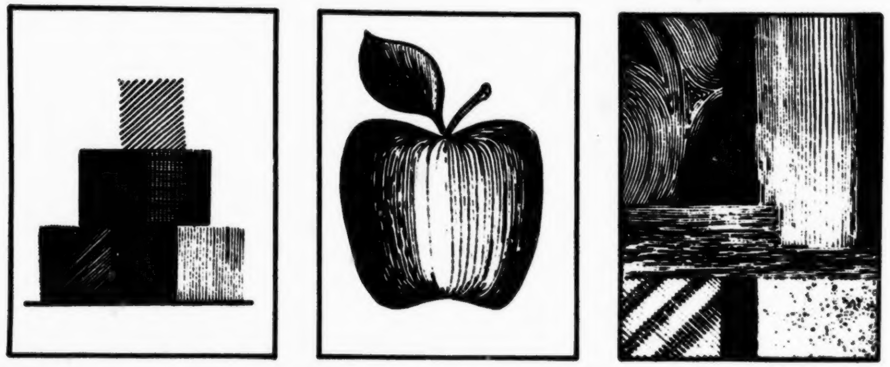


FIGURE 32. POLY-ACHROMATIC PICTURES

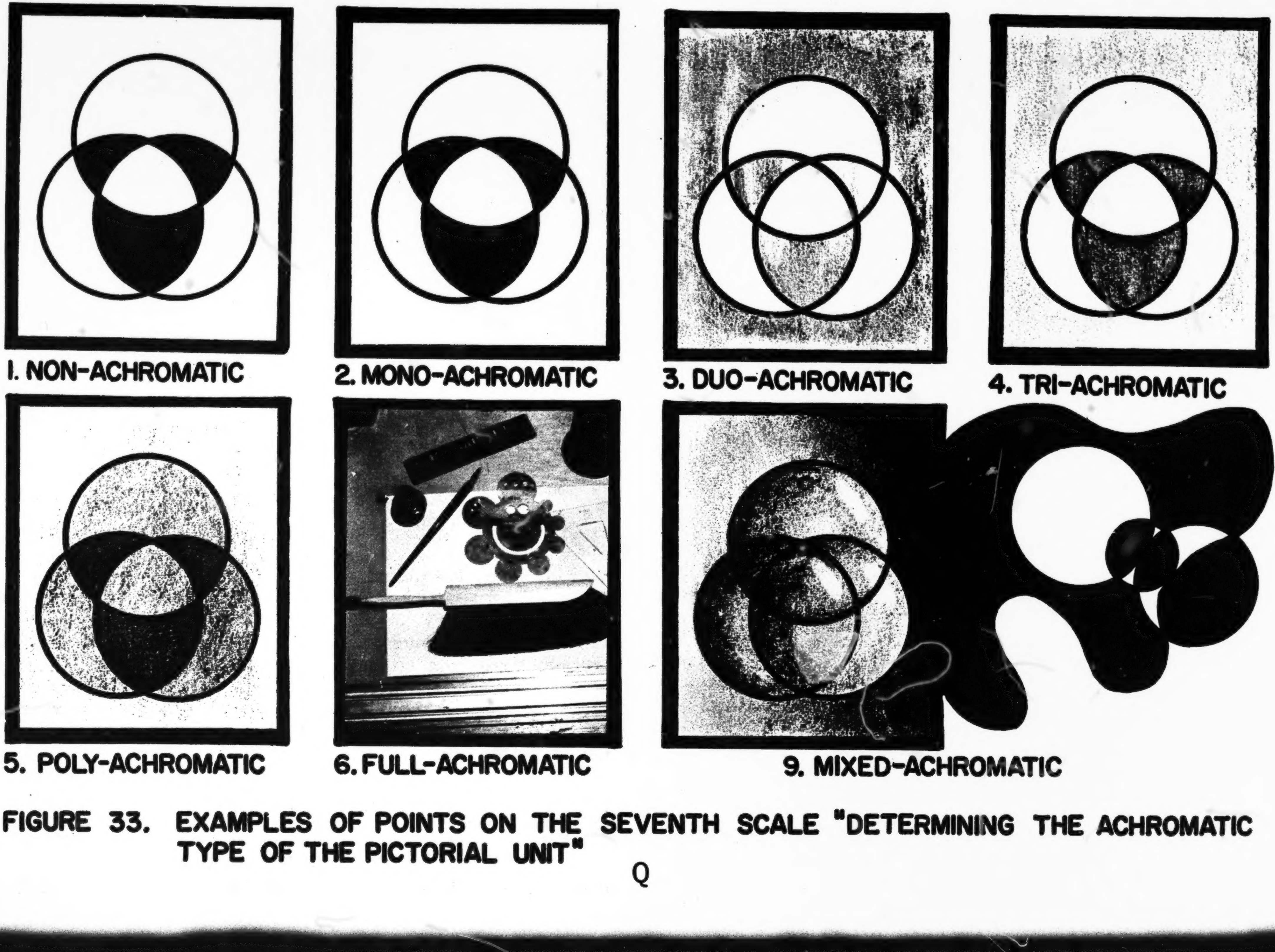
Note Point 5 and Point 6 of this Scale are designated as poly-achromatic and full-achromatic. The poly-achromatic designation (Point 5) is intended for those pictures that contain more than three achromatic types but are not perceived as full-achromatic.

Note also Point 9, mixed-achromatic. When the picture is composed of a number of separable units that fall at different points on the scale, use Point 9. Point 9 may also be used for those pictures you feel cannot be classified under Points 1-6. Try to use Point 9 sparingly.

SCALE 7: Determining the Achromatic Type of the Pictorial Unit

Point		Description
1	Non-achromatic	(neither black nor greys are present in the picture)
2	Mono-achromatic	(either black or one shade of grey)
3	Duo-achromatic	(black and one shade of grey or two shades of grey)
4	Tri-achromatic	(black and two shades of grey or three shades of grey)
5	Poly-achromatic	(more than three achromatic types but not full achromatic)
6	Full-achromatic	(appearing like a full black and white photo or realistic drawing)
9	Mixed-achromatic	

P



1. NON-ACHROMATIC

2. MONO-ACHROMATIC

3. DUO-ACHROMATIC

4. TRI-ACHROMATIC

5. POLY-ACHROMATIC

6. FULL-ACHROMATIC

9. MIXED-ACHROMATIC

FIGURE 33. EXAMPLES OF POINTS ON THE SEVENTH SCALE "DETERMINING THE ACHROMATIC TYPE OF THE PICTORIAL UNIT"

Q

SCALE 8: Determining the Type of Encoding Medium Used in Creating the Pictorial Unit

The eighth physical property to be classified is the type of encoding medium that was used to create the picture.

The term encoding medium is used to designate the tools or processes by which the picture was originally created. There are an infinite number of methods and techniques for the creation of pictures, and from this universe three have been selected on the basis of ease of recognition of the encoding medium. The three encoding media that were selected were (1) photographic, (2) artistic two-dimensional, and (3) mechanical. A fourth category was included, mixed encoding medium, to account for cases where two or more of the above were used in the creation of the picture. See Figure 34.

The photographic encoding medium is defined as any means whereby the picture was created through the use of a camera or other light-sensitive instruments. X-rays and other radiation prints are also included in Point 1 of the scale. However, in the printing process almost all pictures must go through a photographic translation to make them suitable for printing. If you have some knowledge of the printing process, you might assume that all printed pictures would be classified as Point 1 (Photographic). We are not concerned with photography as a translation medium but rather photography as an encoding medium. Thus, an artist's drawing that must be photographed for the printing process is not to be classified as having been created through photography (Point 1), but rather as artistic-two-dimensional (Point 2). The only pictures that would fall in Point 1 would be those that were originally photographs.

The artistic two-dimensional encoding medium is defined as any means whereby the picture is created by an individual using tools and materials (pencil, crayon, paint, charcoal) which are normally used by artists. The rendering is on a two-dimensional surface. All instances of artistic-three dimensional renderings (models, statues, etc.), since they were photographed to make them two-dimensional, should be classed as photographic (Point 1).

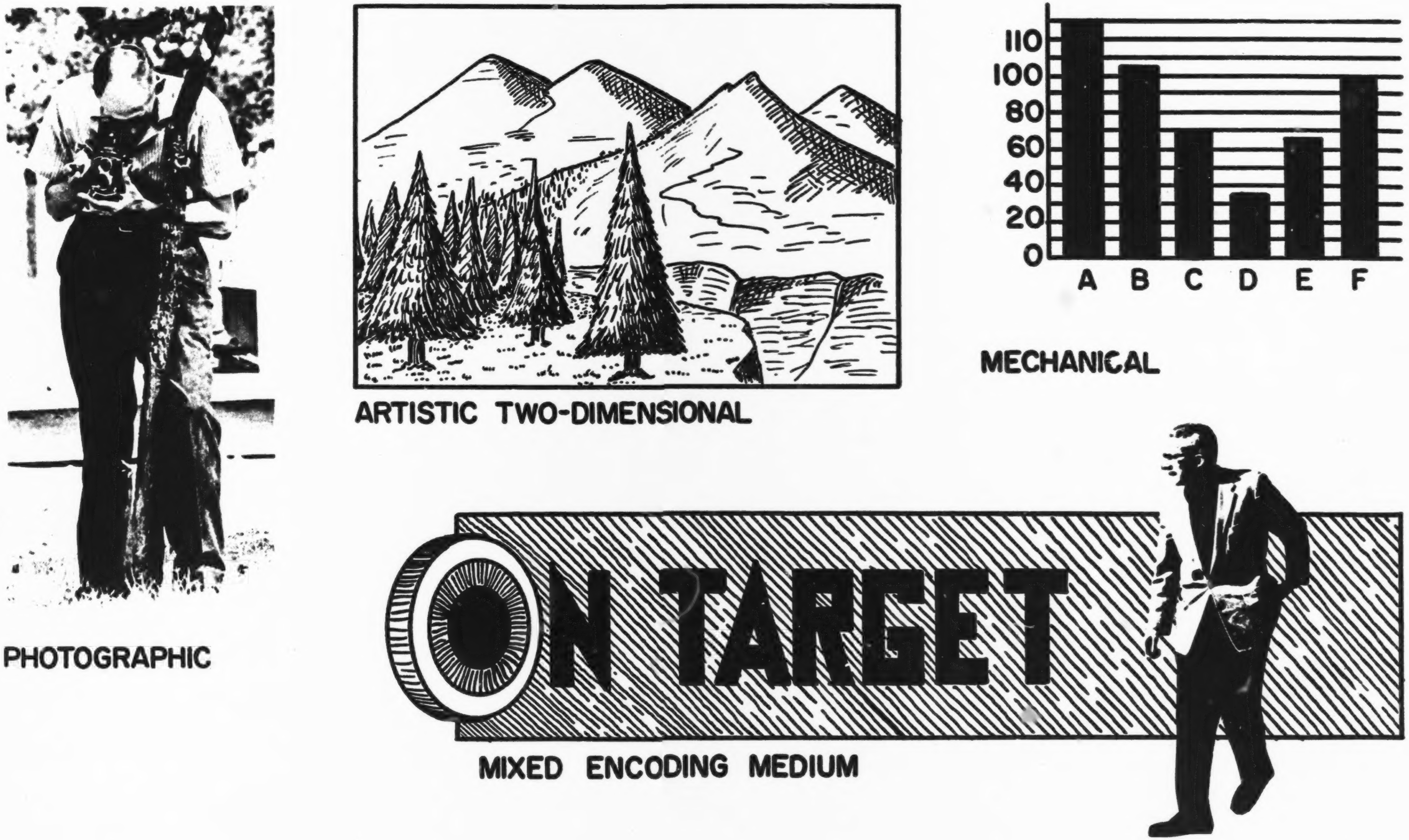
The mechanical encoding medium is defined as any means whereby the picture is constructed by an individual using the tools of draftsmen, cartographers, and graphic artists. Examples of this medium includes maps and graphs; checks, bills, and posters; samples of hand writing; reproductions of documents; train schedules; and many design elements. When pictures are a combination of the mechanical encoding medium (Point 3) and the artistic encoding medium (Point 2), these pictures should be classed as artistic (Point 2). Use Point 3 only when the mechanical nature of the illustration is apparent and separate.

Note also Point 9, mixed encoding medium. When the picture is composed several separable encoding media that fall at different points on the scale, use Point 9. Point 9 may also be used for those pictures you feel cannot be classified under Points 1-3. Try to use Point 9 sparingly.

SCALE 8: Determining the Encoding Medium for Creating the Pictorial Unit

Point	Description
1	Photographic encoding medium
2	Artistic two-dimensional encoding medium
3	Mechanical encoding medium
9	Mixed encoding medium

R


110
100
80
60
40
20
0
A
B
C
D
E
F
ON TARGET

PHOTOGRAPHIC

ARTISTIC TWO-DIMENSIONAL

MECHANICAL

MIXED ENCODING MEDIUM

FIGURE 34. EXAMPLES OF POINTS ON THE EIGHTH SCALE "DETERMINING THE ENCODING MEDIUM FOR CREATING THE PICTORIAL UNIT"

S

SCALE 9: Determining the Encoding Style of the Pictorial Unit

The ninth physical property to be classified is the "style" that was utilized in the encoding of the picture.

Style is defined as that unique treatment of the picture which every creator of illustrative materials aims for as a means of making his pictures different. Historically speaking there are "styles" of art ranging from realistic to abstract. Such terms as cubist, pop art, pointillism, etc., are names of styles. In this taxonomy, style is a difficult concept. We have taken a slightly different approach. We have selected five different terms which we feel will represent five completely different ways of treating pictures, thus five different styles. These terms are: realistic, cartoon, diagrammatic, design, and impressionistic.

Realistic. A realistic style is defined as one typified by a "life-like rendering of the subject." It has a high fidelity to referent. The rendered subject may range from the representation of a unique member of a class to a generalized member of a class.

Cartoon. A cartoon style is typified by the exaggeration and/or simplification of relevant cues. In many instances, it imparts to the subject of the illustration attributes which are abnormal for that subject. The cartoon style may include such things as cartoons and caricatures.

Diagrammatic. A diagrammatic style can serve either of two quite different purposes. First, it can present "hidden material" as in the cutaway or ghosted image to show that which lies beneath the surface. Secondly, a diagrammatic style can present complex information and translate it into more understandable configurations. Charts, graphs, and wiring diagrams are examples of this use of the diagrammatic style.

T

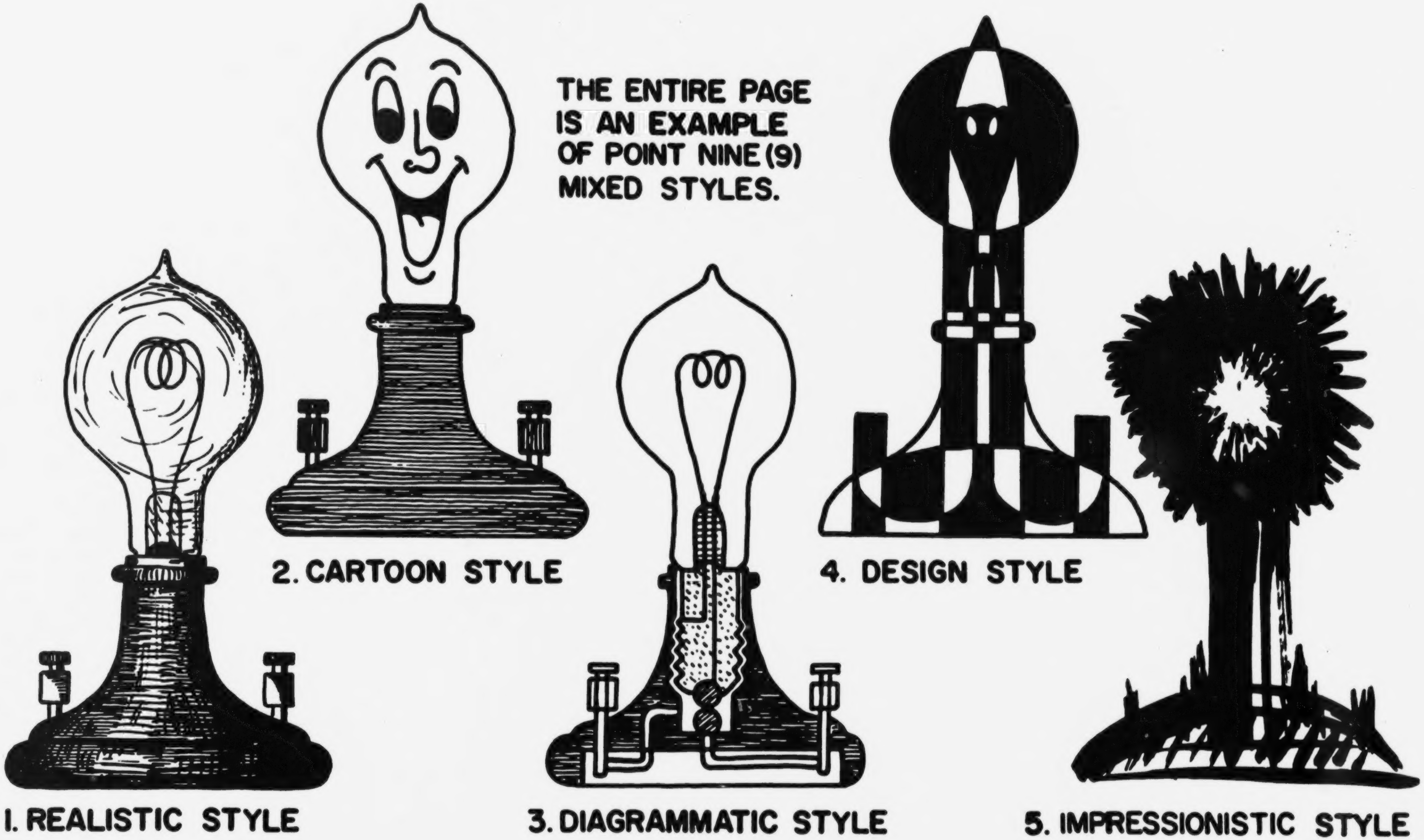
Design. A design style is one in which the presentation of information is secondary, but the enrichment, enhancement, and ornamentation of the page is primary. Generally, pictorial units utilizing this style serve to draw attention to other pictorial units or to verbal elements.

Impressionistic. An impressionistic style is an interpretative deviation from either existing or conceptual referents. Its base is in the individual and the unique perceptions as interpreted by the artist. It is of an aesthetic rather than of an informational nature. Point 9, mixed styles, is included to cover pictorial units which have been designed to incorporate more than one style.

Taken separately, the examples in Figure 35 represent each of the five encoding styles; collectively, they represent Point 9, Mixed styles.

SCALE 9: Determining the Encoding Style of the Pictorial Unit

Point	Description
1	Realistic style
2	Cartoon style
3	Diagrammatic style
4	Design style
5	Impressionistic style
9	Mixed styles



THE ENTIRE PAGE
IS AN EXAMPLE
OF POINT NINE (9)
MIXED STYLES.

1. REALISTIC STYLE

2. CARTOON STYLE

3. DIAGRAMMATIC STYLE

4. DESIGN STYLE

5. IMPRESSIONISTIC STYLE

FIGURE 35. EXAMPLES OF THE POINTS ON THE NINTH SCALE "DETERMINING THE ENCODING STYLE OF THE PICTORIAL UNIT"

U

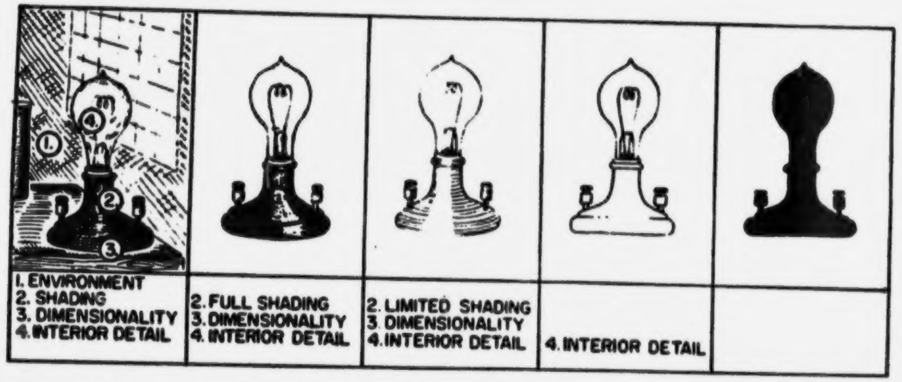
SCALE 10: The Level of Information in the Pictorial Unit

The tenth physical property to be classified is the level of visual detail contained within the picture.

Level of information is defined as the absence or presence of the following factors: (1) the environment or "ground" of the subject of the picture; (2) the shading of the subject of the picture; (3) the dimensional cues other than shading; and (4) the internal detail of the subject of the picture. Any given picture can contain varying amounts of these factors (all, none, or any combination of the above items).

A picture which has the highest fidelity to its referent normally will have the highest level or amount of information. Thus, eliminating these factors from a high-fidelity picture gives a descending order or level of information. For example, given an artistic rendering, such as (A) in Figure 36, all four levels are present (environment, shading, other depth cues, and interior detail). In (B), the environment has been eliminated and the "ground" is now the same ground as the page. In (C), the continuous tone shading has been replaced by a more linear type of shading which is not nearly so detailed. In (D), all shading has been eliminated and the majority of the depth cues have been left out. In the last level, (E), depth cues are extremely limited and all of the interior detail has been eliminated.

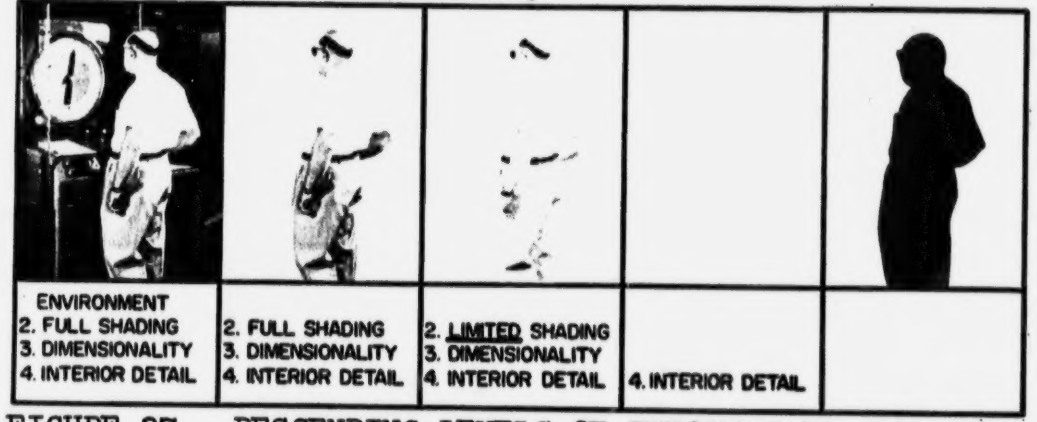
The above five levels of information were designed specifically for the artistic two-dimensional encoding medium, but it is felt that they apply to the photographic encoding medium as well. For example, the first level would apply to any unretouched photographs presented in their entirety (See (A) in Figure 37).



1
4
2
3
1. ENVIRONMENT
2. SHADING
3. DIMENSIONALITY
4. INTERIOR DETAIL
2. FULL SHADING
3. DIMENSIONALITY
4. INTERIOR DETAIL
2. LIMITED SHADING
3. DIMENSIONALITY
4. INTERIOR DETAIL
4. INTERIOR DETAIL

FIGURE 36. AN EXAMPLE OF DECENDING LEVELS OF INFORMATION FOR THE SAME OBJECT

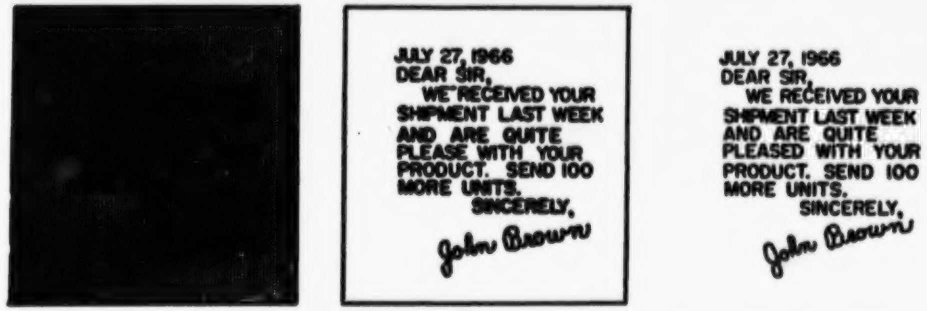
The second level is a masked photograph in which the environment of the subject has been removed. The third level (C), considerably more unusual, is represented by a continuous tone subject that was photographed on high contrast film to eliminate a great deal of shading (note the white shirt). The fourth level (D), one with all shading and the majority of the depth cues eliminated, does not appear possible to represent photographically. The fifth level (E) is best represented by a photogram or a pure silhouette photograph in which all of the interior detail of the subject has been eliminated.



ENVIRONMENT
2. FULL SHADING
3. DIMENSIONALITY
4. INTERIOR DETAIL
2. FULL SHADING
3. DIMENSIONALITY
4. INTERIOR DETAIL
2. LIMITED SHADING
3. DIMENSIONALITY
4. INTERIOR DETAIL
4. INTERIOR DETAIL

FIGURE 37. DESCENDING LEVELS OF INFORMATION FOR THE PHOTOGRAPHIC ENCODING MEDIUM

These five levels of information are even more difficult to relate to pictures created by a mechanical encoding medium. However, there are certain categories that do appear to be of some value. For example, level one (A in Figure 38) is applicable to pictures which were encoded mechanically, only when the "ground" of the picture represents something other than the page. In level two the subject is presented on the same "ground" as the page with an actual frame, while in level three the frame is implied. Levels four and five do not appear to apply to pictures which have been encoded mechanically.



JULY 27, 1966
DEAR SIR,
WE RECEIVED YOUR
SHIPMENT LAST WEEK
AND ARE QUITE
PLEASE WITH YOUR
PRODUCT. SEND 100
MORE UNITS.
SINCERELY,
John Brown

JULY 27, 1966
DEAR SIR,
WE RECEIVED YOUR
SHIPMENT LAST WEEK
AND ARE QUITE
PLEASED WITH YOUR
PRODUCT. SEND 100
MORE UNITS.
SINCERELY,
John Brown

FIGURE 38. DESCENDING LEVELS OF INFORMATION FOR THE MECHANICAL ENCODING MEDIUM

It is interesting to note that, since the theoretical base for Scale 10 is "fidelity to referent", not all level one pictures are equal. A level one photograph will normally have a higher fidelity to its referent than a level one artistic two-dimensional picture. See Figure 39.

The elements within the description of any point on the scale are arranged in a descending order of importance. To use the scale give the highest priority to the first element(s) in the description of each point.

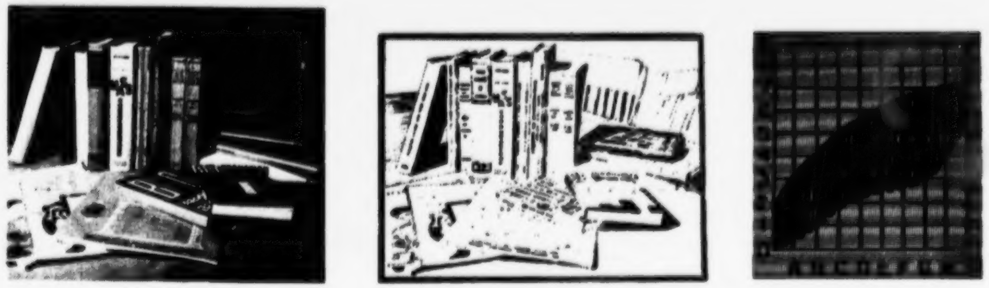


FIGURE 39. LEVEL ONE FOR THE THREE ENCODING MEDIA

Point 9 on this Scale, mixed levels of information, has been included to cover examples of pictorial units composed of separable pictures which have different levels of information.

SCALE 10: Determining the Level of Information of the Pictorial Unit

Point	Description
1	Natural environment, full shading, full dimensionality, full interior detail
2	In limbo, full shading, full dimensionality, full interior detail
3	In limbo, limited shading, limited dimensionality, full interior detail
4	In limbo, no shading, limited dimensionality, limited interior detail
5	In limbo, no shading, no dimensionality, no interior detail
9	Mixed levels of information

SCALE 11: Determining the Degree of Unification/Separation of the Elements Within the Pictorial Unit

The eleventh physical property to be classified is the degree to which the elements of the picture are either unified as a totality or separated into discrete parts.

A pictorial unit has been defined as any readily isolable or separable portion of the page that contains pictorial elements. Note, that in some cases (Figure 40, B and D), the pictorial unit appears to be composed of separable pictures -- pictures which can be distinguished as entities within themselves. In the above cases these pictures have been treated in such a manner that they are effectively combined with other pictures to form over-all pictorial units.

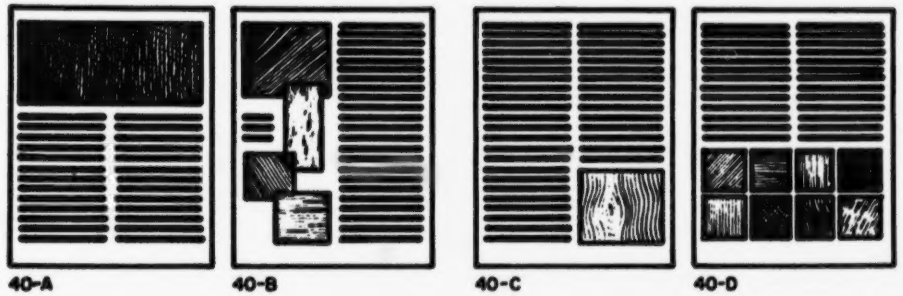


FIGURE 40. EXAMPLES OF PICTORIAL UNITS

In other instances these pictorial units have been so ineffectively treated that it is as easy to perceive them as separate pictures as it is to perceive them as a combination of pictures or a pictorial unit. Thus, within a pictorial unit, we can have separate pictures. A picture is defined as the largest collection of pictorial elements (along with design and/or verbal elements) which maintain a homogeneous unity.

X

When the pictorial unit is composed of one homogeneous picture, there is no problem and it can be classified as Point 1 on the Scale (completely unified). Likewise, when the pictorial unit is composed of "un-unified" and separate pictures, there is no problem; it can be classified as Point 5 on the Scale (completely separate). The problem arises when there is some perceptual difficulty in determining the degree of unification or separation. To assist you in this task, we will now consider some of the perceptually oriented rules for unifying and/or separating.

Proximity is one rule for perceptually unifying or separating elements. Proximity may range from mere adjacency to actually overlapping or being inside a larger visual (See Figure 41). While proximity is a strong cue for determining unity, it varies in terms of "how proximate". If the pictures are inside a larger pictorial unit, proximity is a stronger unification cue than mere overlapping. And overlap is a stronger cue for unification than mere adjacency. Thus, within the concept of proximity, we can see that the degree of unification/separation is determined in part by the degree of proximity present.

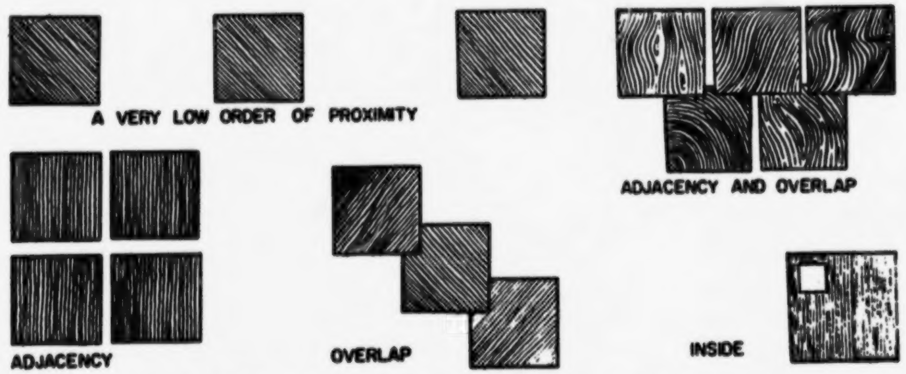


FIGURE 41. EXAMPLES OF DEGREES OF PROXIMITY

Commonness or similarity is another perceptual cue for unification/separation. We tend to group like things. Thus, the degree of similarity may assist in determining the degree of unity. Pictures having a common configuration, a common ground, common subject matter, common color, etc., may easily be grouped into a unified pictorial unit. Vary the degree of commonness in any of these factors and you vary the degree of unity that is achieved.

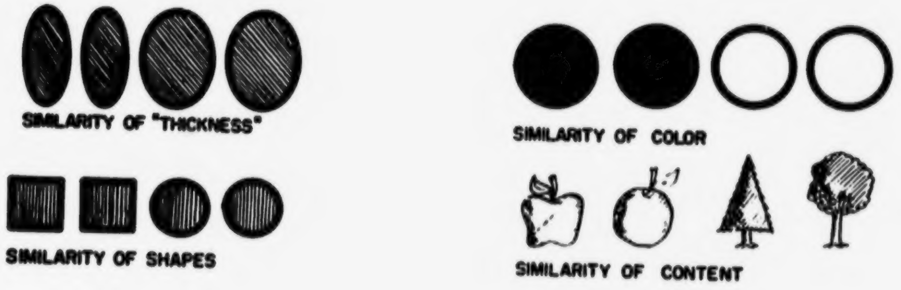


FIGURE 42. EXAMPLES OF SIMILARITY USED PERCEPTUALLY TO UNIFY/SEPARATE PICTURES

There are other perceptual principles that can be applied to either unification or separation. You are to judge perceptually which point on the scale is most appropriate to the pictorial unit that you are classifying.

Y

SCALE 11: Determining the Degree of Unification/Separation of the Pictorial Unit

Point	Description
1	Fully unified
2	Mostly unified
3	About as unified as it is separated
4	Mostly separated
5	Fully separated

APPENDIX G

TEACHERS AND SCHOOL SYSTEMS PARTICIPATING

School System	English	History	Mathematics	Science
Indianapolis, Indiana	Mr. Gail Smith	Mr. Robert Brinkmann Mr. Theodore Cox Mr. Dwight Shaw	Mrs. Gwendolyn Beeler Mrs. Ruth Wolgamuth	Mr. Kenneth Bell Mr. Ozro Stuckey
Bloomington, Indiana	Mr. William Geisert	Mr. Jerry Gregory Mr. John Hatfield Mrs. Bea Johnson	Miss Avis Rector Mr. Peter Williams	Mr. Allen Morrison Mr. Richard Stuart
Lakeland School Corporation LaGrange, Indiana	Mrs. Elizabeth McCally	Mrs. James Armstrong Mr. Boyd Grove Mr. Richard White	Mr. Keith Carper Mr. John McCormick	Mr. Earl Gieseke Mr. David Wiant

APPENDIX H

OBJECTIVE TAXONOMY

Description of the Project

This study is entitled "Instructional Illustrations: A Survey of Types Occurring in Print Material for Four Subject Areas." It is supported by a grant from the U.S. Office of Education to the Audio-Visual Center of Indiana University.

The purpose of the study is to make a systematic beginning in the process of critically appraising the educational role and efficiency of textbook illustrations. As you are well aware the illustrations in modern eighth-grade textbooks consume a large amount of page area and contribute importantly to the costs of publishing. However, it is considerably less apparent what contribution they make to the meeting of educational goals.

The first step in answering the question of educational role or purpose is to obtain from experienced and creative teachers their judgments as to specific educational objectives that each illustration might serve. You are being asked to contribute from your professional training and experience to this phase of the study.

Your Task

Your task will be to write one educational objective (following a prescribed format) for each of approximately 100 illustrations selected from textbooks in the subject matter you teach. We have based your task on the assumption that teachers, using a textbook either as a reference or as a basic text, do use textbook illustrations with students. Therefore, teachers, such as yourselves, are the best judges of the objective a given illustration can fulfill.

We have further assumed that the objectives you write can be categorized, provided they are written in a consistent style. To assure consistency, we have chosen the "student-behavioral" objective as the prescribed format for writing an objective.

PHASE I
The "Student-Behavioral" Objective

A "student-behavioral" objective is one stated in terms of the observable behavior the teacher wants to elicit from the student (learner).

Observable behavior requires that the student (learner) "do something"--"something" the teacher can check in some way as to whether or not the desired learning has taken place. In fact, a well-stated, "student-behavioral" objective can easily be transformed into a test item. For example, in the "student-behavioral" objective, "To name the present-day independent nations in Africa," the testing of the student's learning could be either an oral or written response to a test item stated as, "What nations in Africa today are independent?" or "Name the present-day independent nations in Africa."

Below are eight examples of "student-behavioral" objectives. Following the prefacing statement, "The student should be able . . . ," note that we have used the infinitive form of the verb. Also, note the specificity of each of the eight verbs: solve, define, write, classify, criticize, design, explain, and compare.

Examples: The student should be able . . .

1. to solve for X in the equation X + 3 = 12.
2. to define the term "filibuster".
3. to write a formal invitation.
4. to classify rocks according to the three main kinds: igneous, sedimentary, metamorphic.
5. to criticize national conventions as a means of selecting presidential and vice-presidential candidates for national elections.
6. to design a terrarium or an aquarium that shows the interdependence of living things.
7. to explain the origin of the following words: sandwich, capricious, bankrupt.
8. to compare the area of Triangle A with that of Triangle B.

Types of Objectives

To assist you in writing student-behavioral objectives and to provide a uniformity of format necessary for our classification requirements, we have found an objective can be considered as one of five types: Knowledge, Analysis, Synthesis, Application, and Appreciation.

We have defined these five types as follows:

Knowledge (Type A)--To recall, recognize, reproduce (subsequently and essentially as learned) the information obtainable from the illustration.

Analysis (Type B)--To separate, identify, compare the components of the illustration (physical components or ideational components).

Synthesis (Type C)--To combine, formulate new relationships, generalize from information obtained in the illustration.

Application (Type D)--To use information (known or given) that involves the illustration (but not for the purposes of analysis and synthesis).

Appreciation (Type E)--To show desirable interest, attitude, attention toward the illustration or its subject matter.

Note that different infinitives are used in defining each type of objective. Because particular infinitives help characterize each objective type, we require that they be used in writing your objectives. There will be approximately 10 infinitives from which to choose for each type of objective.

On the next page is the complete Guide to Objective Types which defines more fully each type of objective by means of examples. These examples suggest other appropriate verbs and show various uses of them, consistent with the category. These examples will be very useful as you decide which type of objective is appropriate for an illustration. The Guide to Objective Types also contains lists of appropriate verbs from which you can choose the verb to begin your statement of an objective.

Procedure for Choosing the Objective

In general you should proceed as follows: 1. study the illustration and context, 2. judge the type of objective that would be most appropriate, 3. write the objective using an appropriate verb from the list of verbs for the type of objective you have choosen.

The basic decision involves is: Of the possible student-behavioral objectives, what is the most appropriate one for this illustration?

General considerations--

1. Consider the context, i.e., the topic of the subject-matter under consideration and the goals you would have for your student when teaching this topic.
2. Assume that an eighth-grade student has studied the book through the page containing the illustration.
3. Assume he is an "average" eighth-grade student in ability and experience.

GUIDE TO OBJECTIVE TYPES

KNOWLEDGE (as a product)

Type A. To recall, recognize, reproduce, (subsequently and essentially as learned) the information obtainable from the illustration, that is:

- to state, write, list information in caption, titles, labels, legends (essentially as given)
- to recall, reproduce, recognize (subsequently) information found in picture, map, graph, drawing
- to recall, (subsequently) any of the products of the following behaviors: analysis, synthesis, application, appreciation.

APPROPRIATE VERBS

Learner should:

state
write
name
label

list
repeat
recall
recognize

reproduce

ANALYSIS (as a process)

Type B. To separate, identify, compare the components of the illustration (the physical components or the ideational components) so as:

- to distinguish, delineate, dissect into parts
- to compare, contrast, find similarities and differences
- to find existing relationships among components (not form new ones, i.e., synthesis)
- to describe, categorize, identify, explain by its components (based on student's analysis)*
- to assess, criticize any components (based on student's analysis)*

Learner should:

differentiate
analyze
find
identify
select
describe
locate

delineate
distinguish
compare
contrast
explain (by analysis)
separate
estimate

categorize
criticize
assess
judge
write
state

SYNTHESIS (as a process)

Type C. To combine components, formulate new relationships, generalize from information obtained in the illustration, so as:

- to summarize, interpret information (not recall of same)
- to restate in a way or translate into a form new to student
- to explain (overall), give example of
- to associate, relate, organize information in illustration in a different way from that given
- to create, design, formulate, plan new products, principles, concepts, procedures, conclusions
- to hypothesize, predict, generalize regarding illustration
- to evaluate whole illustration (based on student's synthesis)*

Learner should:

restate
generalize
summarize
translate
combine
relate
interpret (by synthesis)

explain
create
associate
organize
formulate
plan
prepare

conclude
hypothesize
design
predict
evaluate
write
state

APPLICATION

Type D. To use information (known or given) that involves the illustration (not for the purpose of analysis or synthesis) as follows:

- to apply rules, principles, procedures from the illustration
- to apply rules, principles, procedures to the illustration
- to compute, perform, classify, rate, construct or do some other operation to the illustration or with information from the illustration -- all by application of a known or prescribed method to solve problems relative to the illustration

Learner should:

apply
use
solve
compute

perform
classify
categorize
rate

construct
do
state
write

APPRECIATION

Type E. To show desirable interest, attitude, attention toward the illustration or its subject matter, as follows:

- to show interest in any of a variety of observable ways
- to notice, be attentive to, concentrate on the illustration
- to evidence interest in the illustration itself, in the information obtained from it, in the related unit or chapter
- to exhibit preference for, approval of, values about

Learner should:

show
exhibit
evidence

interest, attention
appreciation, preference
attitude, approval

notice
be attentive to
concentrate on

write
state

*not by application of given rules, procedures, principles, etc.

Specific Rationale--

In relation to the above, but with particular reference to the information obtainable from the illustration, which of the following is the most appropriate type of behavior to expect from the student?

To Know--to recall, reproduce, recognize
To Analyze--to separate, identify, compare
To Synthesize--to combine, formulate new, generalize
To Apply--to use, apply, solve problems
To Appreciate--to show interest, attitude, attention

Examples

Some examples of illustrations and related objectives follow on the next five pages. These have been chosen from your subject-matter area and include an objective of each type A-E.

Note that these examples are labelled Possible Objectives, not the most appropriate objectives. To get the most appropriate objectives, we are depending on your professional judgment. The examples, however, do accurately fit the types of objectives indicated.

Did you notice that each illustration in the examples has been framed with a broken line? The illustrations in the textbooks you will use have been set apart in the same way. Everything within broken lines will be considered an illustration. Illustrations will always contain a picture, map, graph, diagram, drawing, or the like, and may or may not additionally include a caption, title(s), label(s), and legend(s).

Possible Problems

You are by now probably aware that some of the decisions as to the most appropriate type of objective are not unequivocal. Some basic criteria for making these judgments are built into the Guide to Objective Types, page 341. Others will be suggested here.

Two or more possible objectives

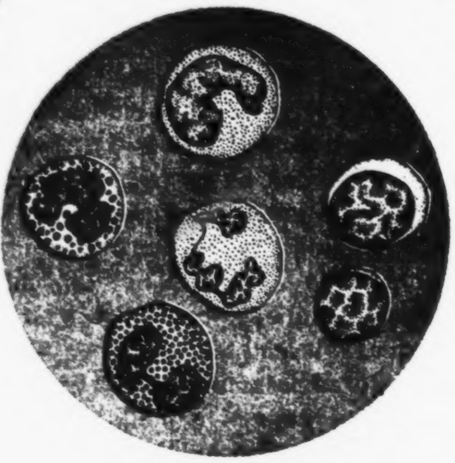
Frequently, two or more types of student behavior are required for a task. For example, writing a theme, Synthesis, may require considerable Analysis of the subject. In such cases you must decide which of the two or more behaviors (objective types) is most essential in the situation, i.e., what you most want the student to profit from doing with regard to the illustration and consequently what will be the basis for subsequent evaluation of the student's work. In the case of the

Whenever germs get inside the body where they can grow and reproduce, the white corpuscles attack them almost at once. Since blood goes to every part of the body, there are white corpuscles all through it. Some stay in one place and attack any germs that come near. Others travel to the place where the germs are and then attack them. Sometimes, instead of destroying the germs, the white corpuscles form a wall that shuts them off. This often happens when tuberculosis germs get into the lungs. The wall keeps the germs and their toxins from spreading. After a while, it becomes thick and hard.

If germs that get inside are not quickly destroyed, the body usually makes more white corpuscles to keep up the fight. As a result, the number of white cells in the blood increases. Such an increase is nearly always a symptom of an infection in some part of the body. So doctors often use this symptom to help them make a diagnosis. A small amount of blood is drawn from the body and examined with a microscope. The white corpuscles in a certain volume of blood are then counted. An extra large number of them ordinarily means that germs are growing and reproducing somewhere in the body. In a severe infection, the blood count may show two or three times as many white corpuscles as usual.

The other main group of germ fighters is made up of chemicals called **antibodies**. *Anti-* means against, while *bodies* refers to the chemicals that attack germs and their products, such as toxins. When germs get inside, the body usually makes antibodies that fight them. Some of these chemicals make it easier for white corpuscles to dissolve germs. Some make germs stick together in bunches so that they cannot be spread through the body. Others destroy germs by dissolving them. Still others change the toxins produced by germs and make these poisons harmless. These antibodies are called *antitoxins*. They neutralize the toxins that germs produce.

Antibodies are quite different from our other defenses against germs. Both the outer defenses and the white corpuscles oppose and stop all kinds of germs if they can. But our bodies make many kinds of antibodies. Each kind of antibody attacks only one kind of germ or toxin. For example, when typhoid-fever germs get inside, the body makes antibodies of a certain kind. These attack the germs and make them stick together in bunches. After the germs have been stopped, the antibodies stay in the blood for some time. Here



White corpuscles

Your blood contains at least six kinds of white blood cells, or white corpuscles. Careful observation with a microscope of a blood sample that has been stained with dyes shows that white corpuscles differ in size, in the number and color of granules in their protoplasm, and in the size and shape of their nuclei.

The kind of white cell that increases in number to fight an infection depends on the kind of infection. For example, the bacteria that cause boils and abscesses cause one kind to multiply. The germs of tuberculosis or malaria cause other kinds to increase. In diagnosing a disease, the doctor may ask for a differential blood count. A laboratory technician then stains a sample of the patient's blood and counts the different kinds of white cells. By knowing which kind of white cell has increased in number, the doctor can sometimes tell what disease the patient has.

Antibodies
are the chemicals made by our bodies to fight the germs, or the toxins produced by the germs, of a certain disease.

POSSIBLE OBJECTIVE
Type A (Knowledge)

To recall the number of kinds of white blood cells and the several ways in which they differ.

(Illustration reprinted by permission from Science Is Understanding by Beauchamp, Mayfield, and Hurd. Copyright 1964 by Scott, Foresman and Company.)

systems. The *nervous system* includes the sense organs, nerves, and brain. Each kind of tissue, organ, or system carries on some special activity for the whole living thing. A pine tree or a bean plant has its cells arranged in tissues, organs, and systems. But since it has neither muscles nor a nervous system, it cannot respond quickly with its whole body to stimuli that it receives. So its behavior is very different from yours or a robin's.

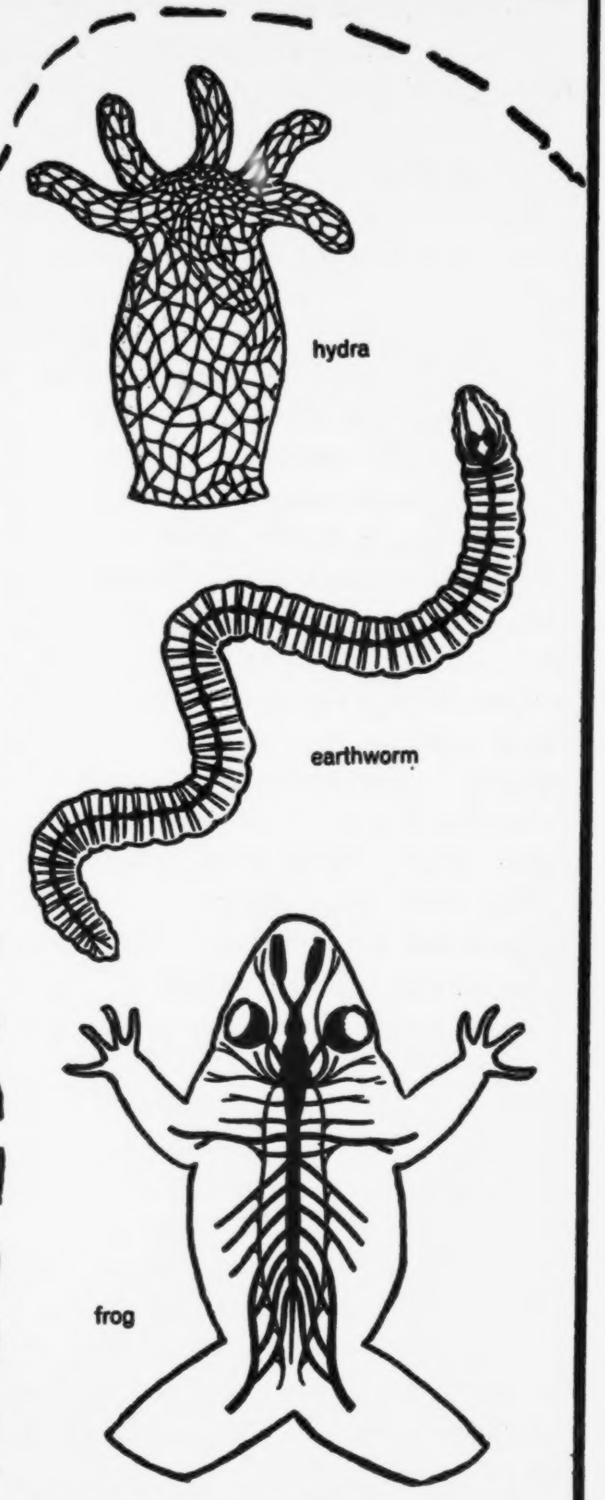
Self-testing exercises 1a

1. What is meant by a stimulus? A response? Give examples.
2. Explain what scientists mean by the behavior of a living thing.
3. Why must every living thing adjust to its surroundings?
4. a. Name four stimuli to which plants respond.
   b. How do they respond to these stimuli?
5. Two things help determine the behavior of any animal or plant. What are these things? Give an example of each one.
6. a. What does a nervous system include?
   b. How does having a nervous system affect behavior?

b What does a nervous system do?

Though animals and plants both carry on certain activities, they do not all behave in the same ways. Depending on stimuli and structure, behavior may be very simple, very complicated, or somewhere in between. No plants have nerve cells. Neither do any one-celled animals. So, of course, they cannot have a nervous system. The simplest many-celled animals are sponges. Full-grown sponges are always attached to something. Since they do not move around, they seem more like plants than animals. Sponges have no nervous system nor even nerve cells. They are little more than a group of one-celled animals living together. Hydras are somewhat more complex animals than sponges. Each hydra has nerve cells. These form a network of nerve tissue throughout its body. But this nerve net is not like the nervous systems of still more complex animals, as you can see from the drawings on this page.

All the activities of the animal are controlled and directed by its nervous system. This enables the animal to respond quickly to stimuli from either outside or inside its body. The



Compare the nervous systems of the animals shown above. The nervous system of the hydra allows only very simple responses to stimuli. The nervous system of the earthworm is more complex and includes a small, undeveloped brain. The frog has a simple brain and organs for smell, sight, and sound.

POSSIBLE OBJECTIVE
Type B (Analysis)

To compare the structure of the nervous systems of the various types of animals pictured.
(Illustration reprinted by permission from Science Is Understanding by Beauchamp, Mayfield, and Hurd. Copyright 1964 by Scott, Foresman and Company.)

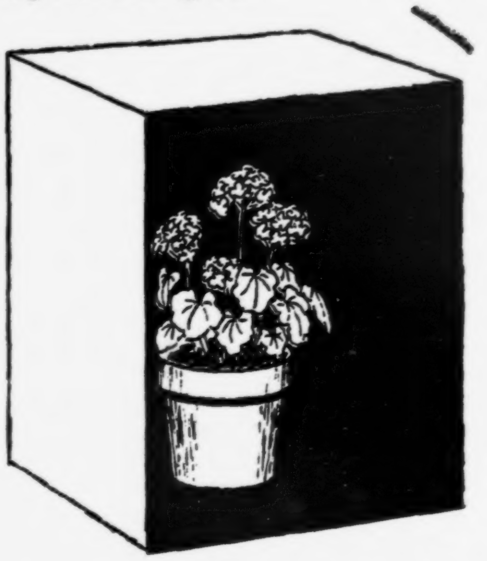
have ways of behaving. They carry on their activities and respond to stimuli in certain ways.

If you plant some seeds such as corn grains, you can see several interesting examples of plant behavior. Regardless of how you put the seeds into the soil, the roots always grow down and the stems always grow up. The roots and stems are both responding to the stimulus of gravity. If the seed is turned on its side, the root will turn downward and the stem upward. You know that the plants must get water and minerals from the soil to make food. Their roots will grow toward the places in the soil where they can get more of what they need. So water and minerals are also stimuli to which the roots respond. The stems and leaves of plants respond to the stimulus of light by growing toward it. If the plants are put in a dark place where light comes from only one side, the stems and leaves will turn in that direction as they grow toward the light.

How plants respond to the stimuli of gravity, water, minerals, and light is explained by the way in which their cells grow. Near the tip of a root or stem, cells are dividing and forming new cells. Other cells directly behind them get larger and help make the root or stem longer. A growth chemical is produced at the very tip of the root or stem. This chemical controls the rate at which the cells grow. More of the chemical makes root cells grow slower but stem cells grow faster. When a plant is turned on its side, gravity pulls more of the chemical to the lower sides of both the root and the stem. The cells on the lower side of the root grow slower, while those on the lower side of the stem grow faster. So the root turns downward as it grows, but the stem turns upward. In a similar way, the chemical makes roots or stems grow and turn in response to other stimuli. By making Observation 1 on this page and Observation 2 on page 160, you can see some examples of plant responses.

These responses of plants are quite different from the responses of animals. Yet what you have learned about plant responses will help you understand certain things about all responses to stimuli, including your own responses. A living thing can receive a stimulus from either outside or inside its body. You are receiving stimuli from outside your body when you see someone you know, hear someone calling you, or smell food cooking. But when you feel hungry, thirsty, or

Observation 1
How does a plant respond to light?



1. Get a box large enough to hold a potted plant. Paint the inside of the box black or line it with black paper. Set the box with the opening facing a window and put a potted geranium in it.

2. Look at the plant each day. What response is it making to light?

3. Leave the plant in the same position until you can observe no more change from day to day. How long did it take to complete its response?

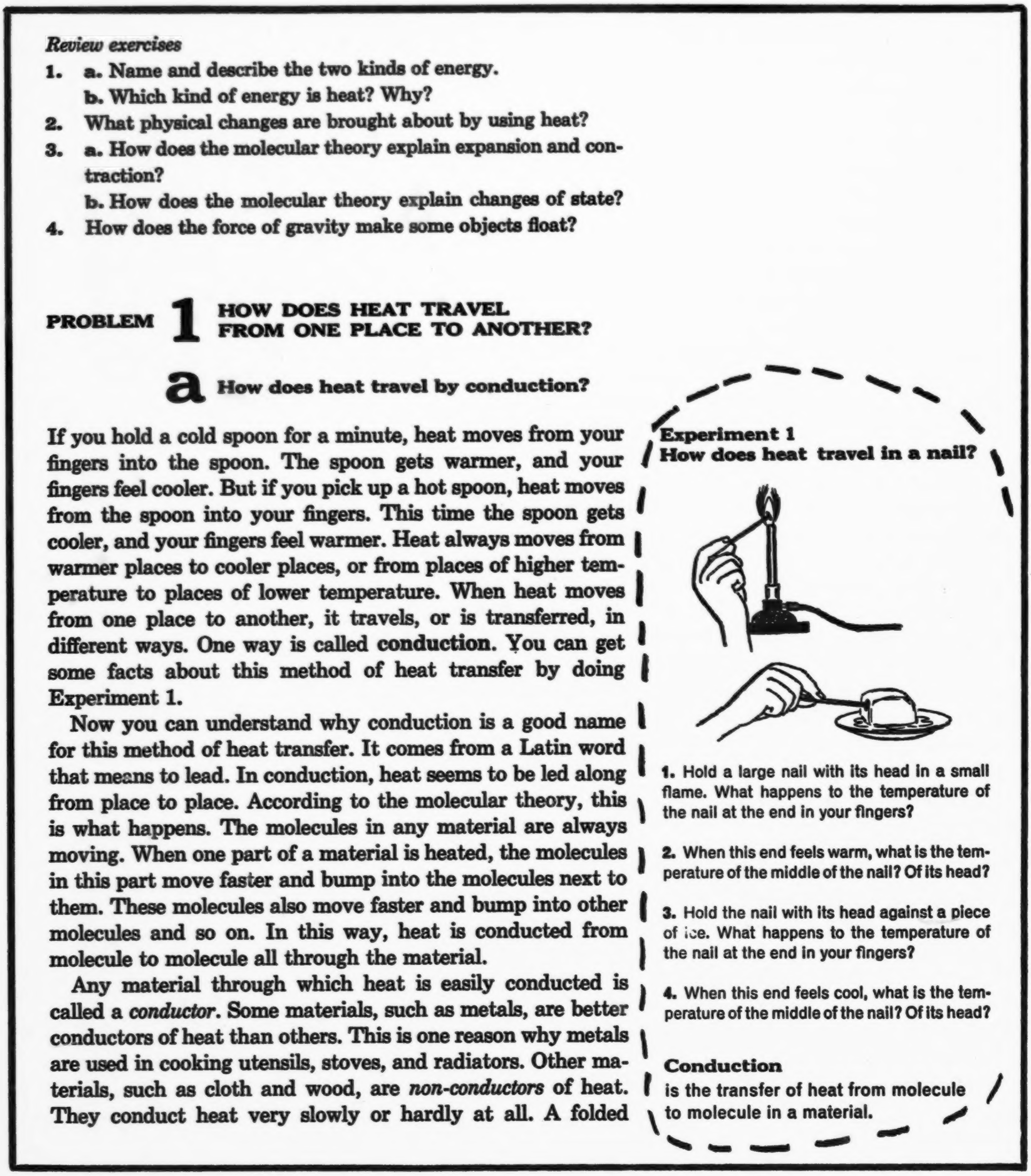
4. Mark the side of the pot that has been facing the window. Then turn the pot so this side faces the inside of the box. Look at the plant each day. Is the same kind of response occurring? How long does it take to complete the response this time?

5. Answer the question of the experiment. Do you think plant responses are fast or slow compared to animal responses? Give examples to support your answer.

6. Try the same experiment with other green plants. Does the same kind of response occur? Is the rate the same? How can you be sure that the response you observed is a response to light and not to something else? How do you think the structure of the plant affects its response to the stimulus of light?

POSSIBLE OBJECTIVE
Type C (Synthesis)

To formulate hypotheses (before the experiment) about the probable length of time required for the plant to complete its response the first time as compared to the second.
(Illustration reprinted by permission from Science Is Understanding by Beauchamp, Mayfield, and Hurd. Copyright 1964 by Scott, Foresman and Company.)



Review exercises

1. a. Name and describe the two kinds of energy.
   b. Which kind of energy is heat? Why?
2. What physical changes are brought about by using heat?
3. a. How does the molecular theory explain expansion and contraction?
   b. How does the molecular theory explain changes of state?
4. How does the force of gravity make some objects float?

PROBLEM 1 HOW DOES HEAT TRAVEL FROM ONE PLACE TO ANOTHER?

a How does heat travel by conduction?

If you hold a cold spoon for a minute, heat moves from your fingers into the spoon. The spoon gets warmer, and your fingers feel cooler. But if you pick up a hot spoon, heat moves from the spoon into your fingers. This time the spoon gets cooler, and your fingers feel warmer. Heat always moves from warmer places to cooler places, or from places of higher temperature to places of lower temperature. When heat moves from one place to another, it travels, or is transferred, in different ways. One way is called **conduction.** You can get some facts about this method of heat transfer by doing Experiment 1.

Now you can understand why conduction is a good name for this method of heat transfer. It comes from a Latin word that means to lead. In conduction, heat seems to be led along from place to place. According to the molecular theory, this is what happens. The molecules in any material are always moving. When one part of a material is heated, the molecules in this part move faster and bump into the molecules next to them. These molecules also move faster and bump into other molecules and so on. In this way, heat is conducted from molecule to molecule all through the material.

Any material through which heat is easily conducted is called a *conductor*. Some materials, such as metals, are better conductors of heat than others. This is one reason why metals are used in cooking utensils, stoves, and radiators. Other materials, such as cloth and wood, are *non-conductors* of heat. They conduct heat very slowly or hardly at all. A folded

Experiment 1
How does heat travel in a nail?

1. Hold a large nail with its head in a small flame. What happens to the temperature of the nail at the end in your fingers?

2. When this end feels warm, what is the temperature of the middle of the nail? Of its head?

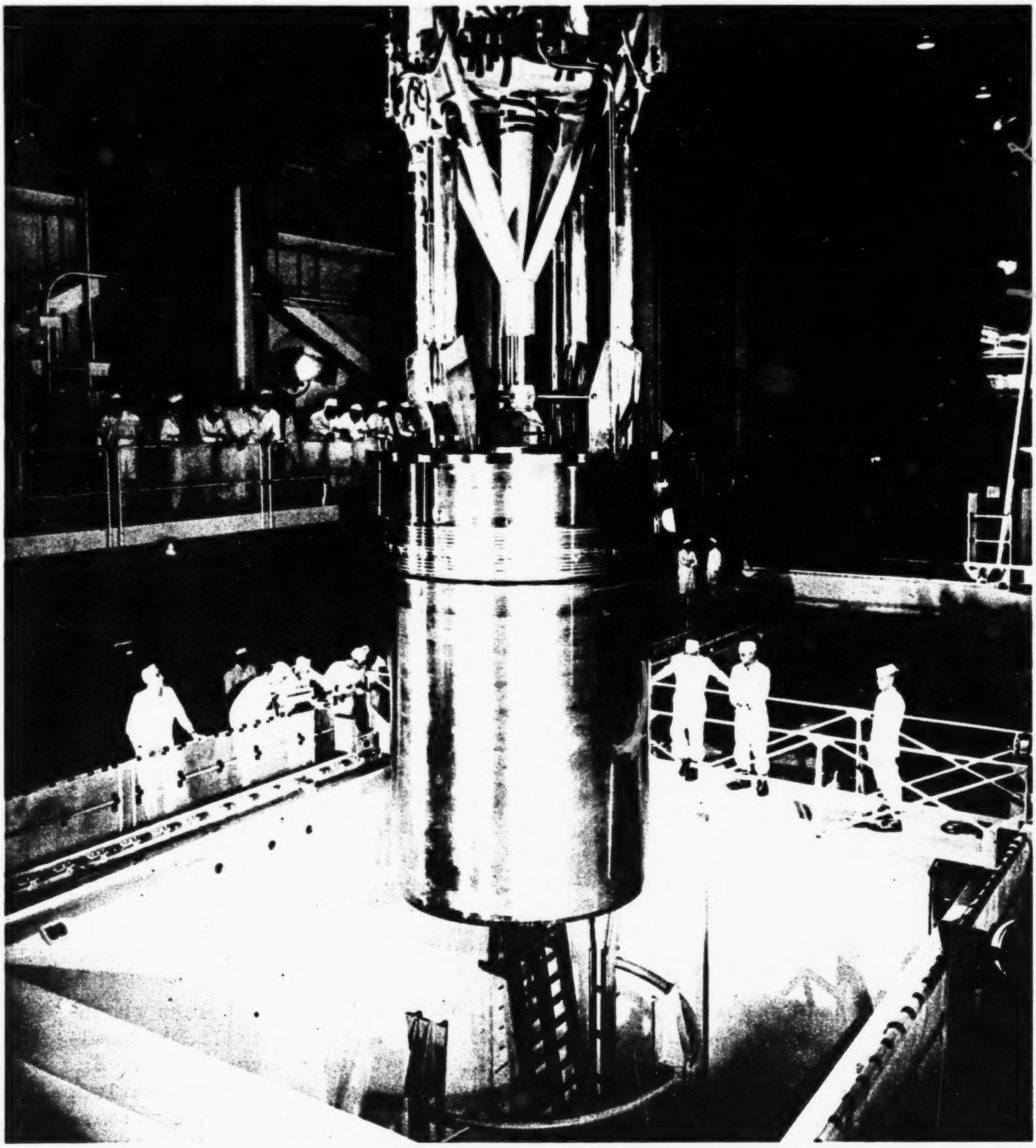
3. Hold the nail with its head against a piece of ice. What happens to the temperature of the nail at the end in your fingers?

4. When this end feels cool, what is the temperature of the middle of the nail? Of its head?

Conduction
is the transfer of heat from molecule to molecule in a material.

POSSIBLE OBJECTIVE
Type D (Application)

To apply the given procedure for conducting the experiment.
(Illustration reprinted by permission from Science Is Understanding by Beauchamp, Mayfield, and Hurd. Copyright 1964 by Scott, Foresman and Company.)



In this picture the nuclear core for the first full-scale atomic power plant to be operated in the United States is being lowered into place. Nuclear fission taking place within the core produces the heat needed to make the steam that drives electrical generators.

POSSIBLE OBJECTIVE
Type E (Appreciation)

To evidence interest in the size and shape of the nuclear core represented. (Illustration reprinted by permission of Westinghouse Electric Company.)

theme, for example, an English teacher may decide that the way the theme is put together, the Synthesis, is the most essential behavior and the one that will be evaluated. Similarly, the Application of a rule to the solution of a mathematics problem may require recall, Knowledge, of the rule, though the teacher may decide that Application is the more essential objective in this case. Likewise, Analysis of a map or science diagram may culminate in some summary statements that bring together, Synthesize, the findings, though the teacher may decide that in this case Analysis behavior is the more essential.

Please do not avoid the decision between types by using two or more in one objective, e.g., to recall and apply a rule. Choose one.

When no infinitive is suitable

If, occasionally, no suitable infinitive is provided for the objective type you have chosen, you may use either "state" or "write." These are not definitive of any particular type of objective, and hence can be used with all. Further, they fit the requirement of "student behavior."

Please use "state" and "write" as sparingly as possible, and be sure your use fits the definition for the objective type chosen.

Use of caption and context

The caption or context may or may not suggest possible objectives for the illustration. However, you are the judge as to the appropriateness of an objective, not the textbook author. You are to choose the most appropriate objective for the illustration, whether the objective is suggested by the caption or context or is never mentioned.

Other sources of information in addition to the illustration

As stated earlier, your hypothetical eighth-grade student comes with a broad background of experiences and a reasonably explicit knowledge of material in the book up to the illustration. Consequently, an objective can and frequently must depend in part on such prior knowledge. However, that particular information which is necessary for the attainment of your objective must have a close relationship to and be clearly dependent upon the illustration, (the material within the broken lines). The illustration must be the focus of the objective.

PHASE II

Rating of Objectives

After you have completed writing the objective for each illustration assigned you, one final part of the process remains--that of rating each objective in terms of the degree of involvement expected of the student.

DEGREE OF INVOLVEMENT--Duration and Intensity of Student's Involvement

	1	2	3	4	5
Scale	Quite Limited	Rather Limited	About Average	Rather Extensive	Quite Extensive

You should look back over each illustration and matching objective and ask yourself the following questions:

What degree of involvement (specifically, the duration and intensity of involvement) does the objective expect of the student--quite limited, rather limited, about average, rather extensive, or quite extensive, in comparison to all of your other objectives?

There are two main criteria for judging the degree of involvement:

1. Student criterion, which might be defined as the amount of time and energy the student might spend in meeting the objective.

2. Information criterion, which might be defined as the amount, novelty, and complexity of information associated with meeting the objective.

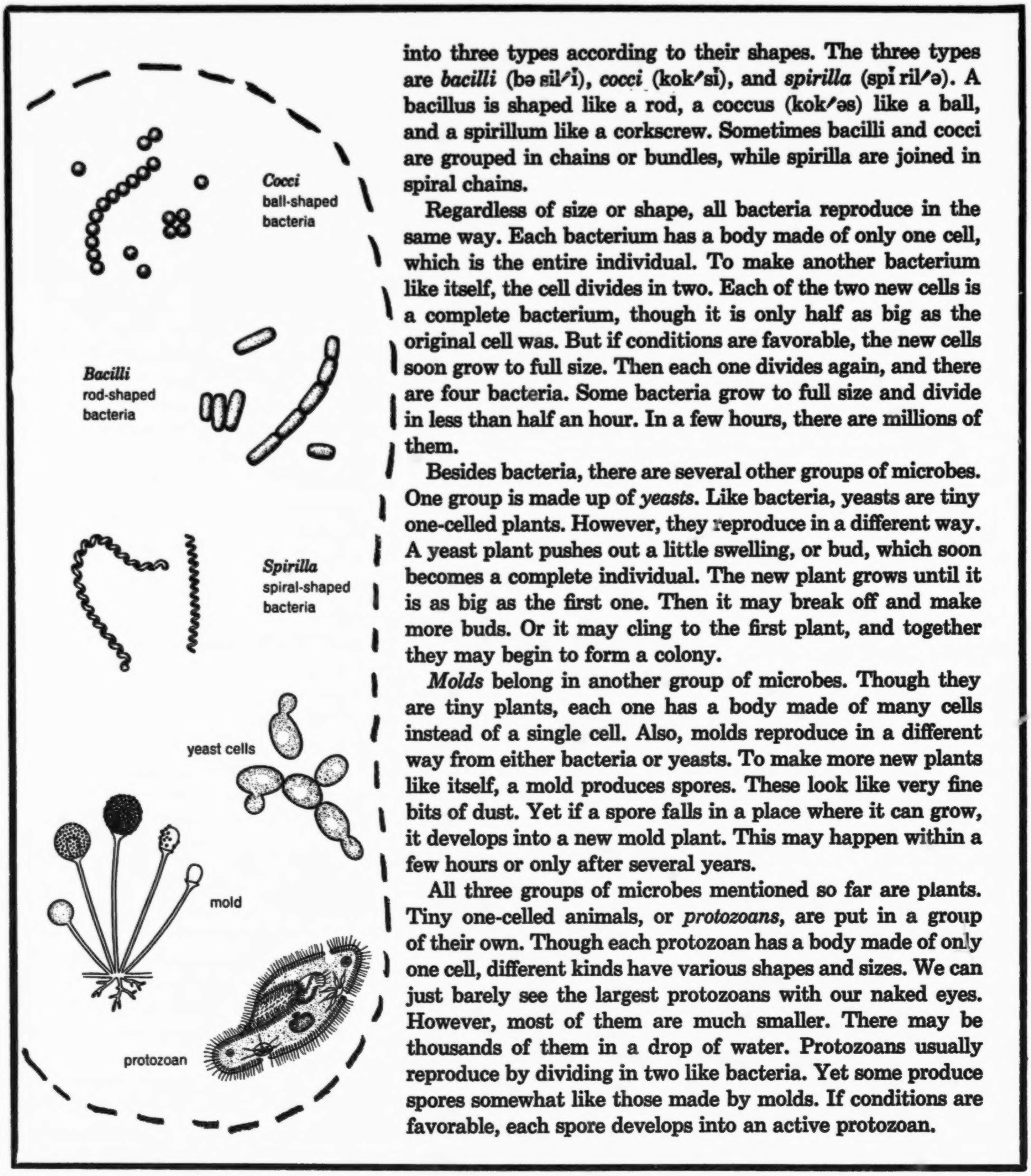
Use both criteria, though we believe that the first is a function of the second, i.e., the amount of time and energy a student will spend is directly related to the amount, novelty, and complexity of the information required.

For example, notice in the illustration(s) on page 350-351 that the amount of information required for the level 1 objective is noticeably less than that for the level 5 objective. Similarly, the amount of the student's time necessary to meet the level 1 objective is clearly less than that needed for the level 5 objective.

The Degree of Involvement Scale should apply equally well across all types of objectives. Knowledge, Analysis, Synthesis, and Application objectives can each vary widely in the degree of involvement they require of the student. Appreciation objectives can vary comparably, i.e., the student might be expected to evidence casual or momentary interest in an illustration or he might be expected to evidence interest of greater intensity and duration such as in a topic for a week or more.

Remember that each of your judgments of degree of involvement is to be made relative to all the other objectives you have written for this study.

Please post your ratings (1-5) on the Tally Sheet opposite the appropriate objectives.


Cocci
ball-shaped
bacteria
Bacilli
rod-shaped
bacteria
Spirilla
spiral-shaped
bacteria
yeast cells
mold
protozoan

into three types according to their shapes. The three types are ***bacilli*** (bə sil′ī), ***cocci*** (kok′sī), and ***spirilla*** (spī ril′ə). A bacillus is shaped like a rod, a coccus (kok′əs) like a ball, and a spirillum like a corkscrew. Sometimes bacilli and cocci are grouped in chains or bundles, while spirilla are joined in spiral chains.

Regardless of size or shape, all bacteria reproduce in the same way. Each bacterium has a body made of only one cell, which is the entire individual. To make another bacterium like itself, the cell divides in two. Each of the two new cells is a complete bacterium, though it is only half as big as the original cell was. But if conditions are favorable, the new cells soon grow to full size. Then each one divides again, and there are four bacteria. Some bacteria grow to full size and divide in less than half an hour. In a few hours, there are millions of them.

Besides bacteria, there are several other groups of microbes. One group is made up of *yeasts.* Like bacteria, yeasts are tiny one-celled plants. However, they reproduce in a different way. A yeast plant pushes out a little swelling, or bud, which soon becomes a complete individual. The new plant grows until it is as big as the first one. Then it may break off and make more buds. Or it may cling to the first plant, and together they may begin to form a colony.

Molds belong in another group of microbes. Though they are tiny plants, each one has a body made of many cells instead of a single cell. Also, molds reproduce in a different way from either bacteria or yeasts. To make more new plants like itself, a mold produces spores. These look like very fine bits of dust. Yet if a spore falls in a place where it can grow, it develops into a new mold plant. This may happen within a few hours or only after several years.

All three groups of microbes mentioned so far are plants. Tiny one-celled animals, or *protozoans,* are put in a group of their own. Though each protozoan has a body made of only one cell, different kinds have various shapes and sizes. We can just barely see the largest protozoans with our naked eyes. However, most of them are much smaller. There may be thousands of them in a drop of water. Protozoans usually reproduce by dividing in two like bacteria. Yet some produce spores somewhat like those made by molds. If conditions are favorable, each spore develops into an active protozoan.

POSSIBLE OBJECTIVE
Level 1 (Type B)

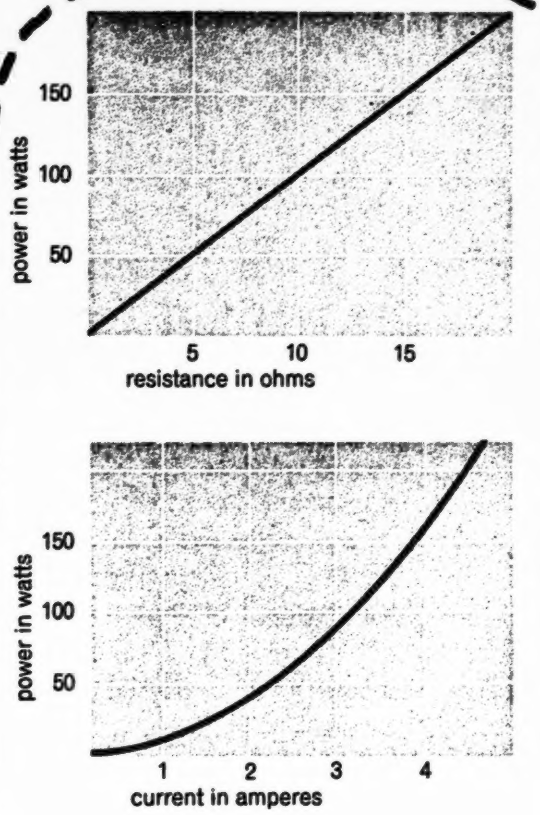
To distinguish between the Cocci, Bacilli, and Spirilla.
(Illustration reprinted by permission from Science Is Understanding by Beauchamp, Mayfield, and Hurd. Copyright 1964 by Scott, Foresman and Company.)

You have learned that power is the rate of using energy or doing work. As you know, we use a unit called the watt to measure the power of an electric current. The number of watts is often called the *wattage*. It tells us how fast electrical energy is used. Scientists planned a very convenient relation between the different electrical units of measurement—watts, volts, and amperes. The power in watts equals the pressure in volts multiplied by the current in amperes. That is, WATTS = VOLTS × AMPERES.

Currents have the same power if their voltages and amperages give the same wattage. For example, at 200 volts a current of 100 amperes has a power of 20,000 watts (200 V × 100 A = 20,000 W). At 20,000 volts a current of 1 ampere has the same power. But if this current flows through the same wires, only 1/10,000 as much electrical energy will be changed into heat. You can now understand another reason why a higher voltage is required. By making the voltage higher and the amperage lower, far less electrical energy is wasted in flowing through wires.

Generators usually do not produce current at high enough voltages to transmit it economically over long distances. Los Angeles gets some of its electrical energy from Hoover Dam on the Colorado River, 270 miles away. Here the generators produce current at 16,500 volts. Though this is a high voltage, a much higher one is needed for economical transmission. So the voltage is first raised, or *stepped up*, to 287,000 volts before the current is sent through the transmission wires. Then near Los Angeles the voltage is lowered, or *stepped down*, so that the current can be distributed more safely. The voltage is lowered in several stages until it is finally at the proper amount for household or other use.

The device used to change the voltage is called a **transformer**. This is a good name for it, because it can transform a lower voltage into a high voltage or do just the opposite. What you have learned about generators will help you understand how transformers work. You know that a generator produces electric current by magnetism. Mechanical energy is used to keep some part of a generator turning all the time that it is supplying current. As either the armature or the field magnets rotate, wires in the armature coil cut across lines of force in the magnetic field. A transformer also produces electric current by magnetism, though it has no moving parts.



You know that WATTS = VOLTS x AMPERES. And, according to Ohm's law, VOLTS = AMPERES x OHMS. So WATTS = AMPERES x OHMS x AMPERES. This is illustrated by the graphs above. They show the rate at which heat is produced when an electric current flows through conductors. The top graph shows the power lost when the same current is sent through different resistances. Does a conductor with twice as much resistance give off twice as much heat in the same time?

The bottom graph shows that the power lost in a conductor varies with the current sent through a conductor. Does twice as much current cause twice as much heat to be given off in the same time?

A transformer
is a device used to change a lower voltage into a high voltage or do just the opposite.

POSSIBLE OBJECTIVE
Level 5 (Type B)

To contrast the rate of power loss with changes in resistance to that with changes in current.
(Illustration reprinted by permission from Science Is Understanding by Beauchamp, Mayfield, and Hurd. Copyright 1964 by Scott, Foresman and Company.)

Final Overall Instructions
Phase I

1. The number of books each of you has been assigned will vary (10 for English, 5 each for Math and Science, and 3 or 4 each for History). Because we need a total of approximately 100 illustrations and because we have selected about 6% of the illustrations from each textbook, considerably more English books were required to yield a comparable number of illustrations.

2. Each illustration for which you are to write an objective has been assigned a number. Locate each illustration by the numbered tabs at the edge of the appropriate book pages. Although numbers are sequential within a book, there may be breaks in numerical sequence between books.

3. Some tabs are numbered on the top surface and some on the bottom. Placement of the number is your cue as to which surface of the tabbed page bears the selected illustration.

4. The illustration is marked off by broken lines and may vary from a small part of one page to an entire double-page spread.

5. When you have located one of the selected illustrations, note the general context in which it appears--chapter and subheadings.

6. Study thoroughly the illustration and write the objective that seems most appropriate to you. Be guided especially by the Specific Rationale and the Guide to Objective Types.

7. On the Tally Sheets supplied (sample attached) enter the information indicated.

8. Be sure the infinitive form of the verb expresses the behavior the student should be expected to evidence as a consequence of his study of the illustration.

9. See that each objective as a whole is consistent with the type you have assigned it.

10. Repeat for each of the tabbed illustrations.

Phase II

1. Reexamine each illustration and associated objective.

2. Rate each objective on the Degree of Involvement Scale.

3. Remember to make all judgments with reference to all of your other objectives.

4. Enter each rating in the appropriate column on the Tally Sheets opposite your Phase I entries.

Other Information

1. Return books and Tally Sheets to your own school office by noon two weeks from today.

2. If you have comments about the task or would like a copy of the eventual report, please add a note to the material you return.

3. If you have questions or problems call 337-1983 or 337-9442, Dr. Fleming.

4. Barring unexpected red tape, your $100 check will be mailed sometime within the next month.

TALLY SHEET (SAMPLE)

PHASE #1			PHASE #2
Illustration Number (from book tab)	Objective Type	Student Behavioral Objective: With particular reference to the illustration the student should be able to:	Degree of Involvement
790	B	To contrast the appearance of the green plant before the experiment to that after the experiment.	2

APPENDIX I

EDUCATIONAL OBJECTIVES

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
		ENGLISH OBJECTIVES	
1	4	To apply procedures for using a rating scale to evaluate study habits as rated on a checklist form.	5
2	2	To identify personal pronouns.	1
3	1	To recognize the different types of cross reference cards.	1
4	5	To evidence interest in play production.	4
5	5	To be attentive to the need for checking work done on evaluating a study unit.	1
6	5	To exhibit appreciation of the sea.	2
7	2	To describe the various things found in an aquarium.	4
8	5	To be attentive to the need for avoiding monotony in speech.	2
9	5	To concentrate on the things that a good, friendly letter should contain.	3
10	5	To evidence interest in the unit on "How Well Do You Read?"	4
11	5	To evidence interest in the unit on nouns.	1
12	3	To generalize a "truth" regarding the necessity of making accurate descriptions of things we see.	3
13	2	To differentiate between times to speak and times to listen.	4
14	3	To explain the tall tale told in the comic strip.	2
15	1	To recall that certain verb forms are used to describe the pictured actions.	2
16	5	To exhibit interest in a wide variety of reading.	3
17	4	To apply rules of discretion in discussing movies.	1
18	1	To recall the vast amount of information available through the use of these books.	5

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
19	2	To compare a polished paragraph with an accomplished golfer, showing that neither is forceful without proper technique.	1
20	1	To recognize the necessity for accurate spelling.	3
21	1	To recognize the five parts of a well written friendly letter.	1
22	4	To apply rules of finding simple and compound subjects in sentences.	3
23	2	To identify the components of a "bread-and-butter" note.	4
24	1	To reproduce a speech chart for use in evaluating a series of speeches.	5
25	1	To recall the various uses of capital letters.	3
26	5	To evidence an interest in our intricate spelling rules.	5
27	1	To recall the correct forms of verbs see, come, do, go, eat, and fall.	2
28	4	To solve a crossword puzzle involving tricky words and phrases relating to vocabulary and grammar.	5
29	2	To contrast the caption below this illustration with the one on page 202.	2
30	1	To recall that a good paragraph contains only one main idea.	2
31	1	To recognize the importance and the use of the card catalogue.	3
32	5	To show an interest in proper English usage.	5
33	2	To analyze the note as a proper form for writing future invitations.	5
34	2	To distinguish between the terms "puzzle" and "arouse curiosity".	1
35	4	To perform a segment of choral reading according to given directions.	5
36	5	To evidence interest in a unit relating to the importance of study.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
37	5	To notice the importance of using the dictionary for making good word choices.	1
38	2	To identify the components of a "bread-and-butter" letter.	4
39	5	To evidence interest in historical locations in a unit on retelling stories based upon the past.	1
40	3	To explain with reference to the illustration the proper behavior patterns in conducting a business meeting.	4
41	2	To distinguish the difference in function of the following from the preceding sections.	1
42	3	To combine the components, showing that separately they are but fragments--combined they are a sentence.	4
43	5	To evidence an interest in the accompanying exercise.	1
44	1	To recall that double negatives must be avoided.	2
45	1	To recognize the rule concerning the correct use of reflective pronouns.	3
46	3	To associate the fact that: the comma in the caption separates the name of the bridge from the city in the same manner the bridge separates the cities.	3
47	5	To evidence interest in an exercise on gerunds.	2
48	5	To evidence interest in a unit on improving one's spelling.	3
49	5	To evidence interest in the accompanying dialogue.	1
50	5	To evidence interest in a story about a barber.	1
51	3	To interpret the loneliness of the setting of the story.	1
52	5	To evidence interest in a unit on the writing of poetry.	3
53	2	To compare the space-pilot's need for skill to our need for sentence skill.	5
54	1	To recall rules of capitalization.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
55	4	To apply knowledge of the active and passive voices to the action in the picture.	3
56	1	To write the tense, person, and number of the italicized verb.	3
57	5	To evidence interest in the importance of using colorful adjectives.	1
58	4	To use voice projection so everyone can hear you.	2
59	4	To solve the direct and indirect quotation exercise that is relative to the illustration.	2
60	2	To explain (by analysis) the meaning of the word heavy as applied to a blizzard.	2
61	3	To create a picture in the mind before attempting to write a descriptive paragraph.	3
62	2	To contrast block style with indented style of addressing envelopes.	5
63	2	To assess a poem for its theme, rhythm, and meaning.	5
64	2	To find similarities and differences in languages.	3
65	2	To compare a well constructed stone structure with a well constructed sentence.	3
66	1	To recall that these two books contain an unlimited amount of information, published yearly.	5
67	1	To write an invitation according to form indicated.	5
68	5	To notice how honesty, directness, and tact are desirable traits in dealing with others.	4
69	5	To evidence interest in participating in a meeting.	1
70	1	To recall the principal parts of a verb.	4
71	4	To write an accurate description of a machine.	4
72	2	To state what information is desired when conducting an interview.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
73	5	To show interest in a variety of activities.	3
74	5	To evidence interest in group discussion.	4
75	1	To recognize the fact that marsupials carry their young in a pouch.	2
76	5	To evidence an interest in reading.	4
77	2	To describe the platypus or other unusual animal life.	3
78	5	To be attentive to the concentrated effort required to prepare a good report.	4
79	2	To compare the test of success in bowling with success in writing effective sentences.	2
80	2	To compare the interpretation of ideas expressed with an improper choice of pronoun with the idea intended.	4
81	1	To recall the information he has learned regarding the comparison of adverbs.	4
82	2	To identify the underlined words as to type of verbals.	2
83	3	To relate the illustration to a complex sentence.	2
84	2	To compare practice for proficiency in music with practice for proficiency in English.	2
85	5	To evidence interest in wanting to read About Part Four.	2
86	4	To write an original descriptive paragraph about someone you know.	3
87	3	To write a dictated passage correctly in terms of specific words that are troublesome, i.e., there, they're, who's, whose.	4
88	1	To recognize that some plurals are formed in an unusual way, e.g., ox oxen.	2
89	2	To differentiate between the pronouns used with a singular verb and those used with a plural verb.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
90	1	To recognize when to use the past tense of the verb "give".	2
91	1	To recognize "myself" as the proper form of the pronoun to be used in the example.	1
92	1	To recognize that quotations may change the meaning of a sentence.	3
93	4	To write a paragraph using figures to explain how much it costs parents to keep a student for one month.	5
94	1	To reproduce a properly addressed envelope.	1
95	3	To write a composition about a whale or about whaling.	4
		HISTORY OBJECTIVES	
96	1	To recall that the Aztecs had an advanced civilization.	2
97	1	To recall that Gutenberg was called the father of printing.	3
98	5	To exhibit interest in the Spanish fiesta and the clothing worn by Spanish women.	1
99	1	To recall the fact that, even in colonial times, America's woolen industry was in competition with Britain.	4
100	1	To name the products and areas of the world involved in the triangular trade.	5
101	3	To interpret the map in terms of distances involved and the point of contact between the British-American forces.	3
102	3	To explain how a township is divided into sections and the make up of one section.	5
103	5	To show interest in old currency and what it was worth.	3
104	4	To apply the principles of the Bill of Rights to present day situations.	4
105	3	To associate John Marshall with the power of the Supreme Court through judicial review.	3

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
106	2	To contrast the percentage of people living in the cities to the percentage of farmers in 1790.	3
107	1	To list Martin Van Buren's political offices as well as when he was President.	3
108	1	To recall William Henry Harrison as the oldest man elected to the office of president of the United States and held the shortest term of office.	3
109	2	To compare the increase of population of the free and slaves with that of the growth of new territory acquired by our nation.	5
110	1	To list the free and slave states before the Civil War.	3
111	1	To name the person responsible for the founding of the American Red Cross.	3
112	5	To notice the prices, terms, and information given on the sign put out by the railroad in the 1800's.	1
113	2	To compare the increase of mileage of the American railroad from 1860 to 1910.	3
114	1	To recall Teddy Roosevelt as a great leader of our country.	2
115	2	To identify the different types of projections.	4
116	1	To recall "The Great White Fleet" was a historic world cruise and was another prime example of Roosevelt's slogan.	3
117	3	To interpret the information in the caption as it relates to U.S. foreign policy in the chapter.	4
118	1	To recall that in 1961, U Thant became Acting Secretary-General following the death of Dag Hammarskjold.	2
119	3	To relate the Berlin Airlift to the general pattern of United States-Soviet relations since World War II.	4

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
120	2	To assess the value of presidential press conferences for citizens of the United States.	4
121	1	To recall Herbert Hoover as president of the U.S. and the man many people blamed for the great depression.	3
122	1	To recall that the term interstate means between states and is regulated by the federal government.	3
123	5	To exhibit appreciation for the different types of American art.	1
124	2	To identify the three ships used by Columbus and visualize the type of island he first sighted in the West Indies.	3
125	1	To recognize the French explorers to the New World and the general area in which they explored.	2
126	2	To identify those elements of the illustration that indicate "permanency".	2
127	2	To assess the contribution of Dutch elegance to early American civilization.	2
128	5	To exhibit appreciation for the reproduction of Paul Revere's ride as it was painted by the American Artist Crant Wood.	1
129	2	To associate this illustration, the illustration on P. 158 and corollary reading with the quality; inspirational leadership.	3
130	3	To associate the changes in our country from 1790 to 1830 with new inventions of transportation and communication.	4
131	2	To compare the early picture of the White House in 1800 as to what it looks like today.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
132	2	To describe the hardship encountered by Daniel Boone as he led his family through the Cumberland Gap to the wild frontier of Kentucky.	3
133	3	To predict Andrew Jackson's chances for election as President if he was running in 1968 (assuming "scanty schooling").	2
134	1	To recognize the various territories and the division of free and slave states at the time of the Missouri Compromise in 1820.	3
135	2	To differentiate between Lee's uniform and more recent Military wear.	2
136	1	To recognize the admission of new states between 1861 and 1865 and how the country appeared in 1865 with reference to territories and states already in the union.	3
137	5	To show interest in an early form of rail transportation (trolley car) that ran through the country in Gladstone, Michigan.	1
138	2	To analyze the effect of submarines on sea battles and national defense.	2
139	2	To compare the plan and purpose of the CCC with the current job corps.	2
140	2	To compare TVA with the Monroe Reservoir Project from the standpoint of purpose, size, present (and future) value, expense, problems, utilization of natural resources.	5
141	3	To interpret the importance of a tax cut in the light of our national debt and growing inflation and the increase in the fighting in S. Viet Nam and building the Great Society.	4
142	2	To locate the causeways connecting the Aztec capital to the mainlands.	3
143	1	To reproduce the route the Spaniards explored in their search for gold and rich cities.	4

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
144	1	To recall that Champlain was a French explorer and had the use of one of the few navigation aids, the astrolabe.	2
145	5	To show interest in the information obtained in Unit One.	1
146	3	To associate shipping flour to England with the idea of the colonies serving as a source of raw materials for England.	3
147	3	To generalize about plantation life during the colonial period.	4
148	2	To associate the imports and exports of the colonies to their dependence on European countries.	4
149	5	To be attentive to the figure of Jefferson, the clothing the men wore, the furnishings and pictures, and the information in the caption.	2
150	1	To name some of the European men who aided the colonies in their fight for independence.	4
151	2	To contrast the land claims of the different colonies.	4
152	3	To associate the picture of the jury with the Amendments to the Constitution.	3
153	5	To notice the picture of Sacramento in 1849.	1
154	1	To recall that Daniel Boone built the Wilderness Trail.	1
155	1	To recall that California became the 31st state in 1850.	2
156	3	To restate why the construction of canals and the use of inland waterways was necessary (1850).	4
157	1	To list the major political parties from 1789 until 1841.	3
158	2	To explain what a protective tariff is through analysis of each part of the drawings.	3
159	5	To show interest in the pictures of Generals Lee and Jackson.	1
160	1	To list the major political parties from 1841 until 1881.	3

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
161	1	To recall that paper making is an important industry of the South.	1
162	3	To associate the importance of railroads to the growth of the meat packing industry.	4
163	2	To compare the buildings (World's Fair, 1893) with buildings today.	3
164	2	To contrast the early department store with the present day department store.	2
165	1	To name the farmer's organization that worked for the social and economic advantage of farmers.	2
166	2	To compare the methods of transportation of the late 1800's to the present day.	2
167	3	To explain the importance of education to the spread of the American way of life.	3
168	5	To show interest in one of the engineering feats of the U.S.	3
169	2	To compare a relatively modern kitchen with those of the 18th and 19th centuries.	3
170	1	To list some factors which cause much unemployment after a war.	4
171	5	To show interest in the missile.	1
172	1	To recognize the different types of weapons used in World War I.	1
173	1	To recall the fact that the Red Cross is at work in other countries as well as the United States.	2
174	5	To appreciate the many learning facilities that modern schools provide.	3
175	2	To compare the life of a sailor in Prince Henry's day to that of modern day times.	2
176	3	To explain how life in the new land was different and challenging to the Pilgrims and the possible problems facing our men in space who are planning to go to the moon.	3
177	1	To list several jobs that indentured servants performed.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
178	2	To contrast early handling of mail in the colonies to our present postal system.	4
179	2	To contrast the difference in military campaigns of early wars compared to World War II and Viet Nam.	4
180	2	To compare and contrast the royalists' view and colonists' view of the Navigation and Trade Acts.	3
181	2	To analyze the facts in the picture to determine what was actually occurring in the Boston Tea Party.	3
182	2	To describe the effects that the Embargo Act had on the lives of the people.	4
183	1	To list the new states along the west bank of the Mississippi River admitted in 1812-58.	2
184	2	To contrast the transportation facilities of America today and how we traveled one hundred years ago.	4
185	1	To list various items which one may use to see.	1
186	3	To conclude that the women's drive for more equality helped to improve and reform our nation according to its democratic ideals.	3
187	3	To summarize the western surge which culminated along the Pacific Ocean.	2
188	1	To recognize the many hardships facing the westward pioneers.	2
189	2	To identify the historical objects in the illustration.	2
190	2	To compare and contrast the dress and customs of the 1860's with the 1960's	3
191	2	To contrast methods of campaigning (both for offices and issues) with those of today.	3
192	3	To explain the relationship between the types of housing and the availability of building materials.	4

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
193	2	To compare and contrast the early Labor Day activities with those of today.	3
194	1	To list the purpose and the duties of the Pure Food and Drug Commission.	2
195	2	To find the geographical relationships of the Allied, central and neutral nations.	3
196	1	To recognize the President of the U.S., who was our 29th president.	1
197	1	To recall conditions that led up to the economic disaster in 1929.	3
198	2	To analyze the political differences existing in 1940.	4
199	2	To compare travel on the "clipper" with that of its predecessor.	3
200	1	To recognize the first leader of a newly formed nation--Ghana.	1
201	1	To recognize the importance of the training which the FBI is subjected to prior to becoming law officers.	2
202	1	To recall what CARE does.	1
203	5	To show appreciation for the contributions of Negroes to American culture.	1
204	3	To explain what elements are involved in bringing about a successful space flight.	4
205	3	To hypothesize that if new discoveries are to be made, then someone must rise to the occasion and show the way for the rest to follow.	3
206	2	To describe how early explorers would travel during the winter.	2
207	1	To recall the importance of tobacco in the early colonial period.	1
208	2	To compare and contrast early travel in the New England area with our modes of travel today.	3
209	3	To explain the reasons behind the tyrannical rule of Andros.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
210	3	To generalize that an orderly defeat or failure can actually lead to final success or victory.	4
211	2	To compare and contrast the use of the PT boat in the W.W. II with the use of the whaleboat in the French and Indian War.	2
212	2	To describe the role of the public in the law-making process and how the system of checks and balances works in the United States contrasting this procedure with other countries.	5
213	3	To associate the example of Daniel Boone with the reason why the American frontier was continuously moving westward.	3
214	1	To recall the life of an early ship hand and how he spent his idle hours on a flat boat.	2
215	1	To recognize Lewis and Clark by their pictures.	1
216	1	To list in order each territorial addition to the U.S. after 1783.	2
217	5	To be attentive to the humor in American politics of the 1860 campaign.	1
218	2	To assess the time sequence of events as they occurred in respect to each other.	5
219	3	To generalize that freedom in America is really developed and realized through progress.	4
220	5	To notice how the United States has had distance barriers decreased by the use of the airplane in modern day travel.	2
221	5	To exhibit appreciation for a great American inventor and scientist T. A. Edison.	1
222	1	To reproduce in your mind what an early fair was like and in what ways today the fair has changed.	2
223	1	To recall the great contributions of Ted Roosevelt not only in conservation, interest in public life, but also in the strengthening of the office of the Presidency.	3

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
224	1	To name the first president of the Republic of the Philippines--Manuel Roxas.	1
225	5	To notice how a man crippled with infantile paralysis conquered the ordeals of every day life and managed to become the President of the U.S. and led his country for 13 years.	4
226	1	To name the world's first atomic-powered submarine.	1
227	2	To contrast the way of life in Indo-China with that of your own.	3
228	2	To distinguish some different geographical features of the United States.	3
229	3	To summarize the reasons for the railroads skirting mountains and following the valleys in their movement west.	4
230	5	To be attentive to the different books available to them in connection with the chapter.	1
231	5	To be attentive to the caption Do You Recall?	1
232	2	To categorize, in terms of location and size, the colonial claims of France, Spain, Netherlands and Portugal (1650).	3
233	5	To notice the caption.	1
234	3	To associate the early settlements through the Appalachian mountains to the rivers.	2
235	3	To associate smuggling with the trade and navigation laws imposed by England.	3
236	5	To show interest in this old stamp.	1
237	1	To recall that Washington won victories at Trenton and Princeton on Christmas night in 1776 when he crossed the Delaware.	3
238	5	To show a desirable interest in the formation of our government and the struggle to achieve our present government.	2
239	4	To state simply some of the rules and procedures a foreigner must follow to become a United States citizen.	3

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
240	5	To notice the problems facing a new government.	2
241	1	To recall that although the Indians were considered nomads some of them lived in permanent dwellings.	3
242	5	To exhibit interest in how our new navy fought successfully against the "Mistress of the Sea".	2
243	1	To recognize some of the early American home furnishings.	1
244	5	To exhibit interest in early American cultural growth.	2
245	1	To recall the famous battle cry, "Remember the Alamo", and the fact that many Americans died for Texan independence.	3
246	3	To relate some of the problems and difficulties encountered in making the trip west to California.	4
247	1	To recall the information: (1) the growth of the continental United States (2) the way the land was acquired in 1845, 1848, 1846, 1853.	2
248	1	To recall who Jefferson Davis was.	2
249	1	To recall that Mathew Brady was the first man to record a war by camera.	3
250	1	To recall Andrew Johnson was president and how he came in office and some of his political background.	3
251	1	To recall that the first powered flight lasted only a few seconds.	2
252	1	To recall when planes were first used to carry mail and what the Spirit of St. Louis was.	2
253	1	To name the inventions of each of the inventors.	4
254	5	To express appreciation for the value of barbed-wire fence to farmers.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
255	3	To formulate conclusions about the importance of T. R. Roosevelt's initiation of the park program and the necessity for such conservation to continue.	4
256	1	To recall the role Horace Mann and Mary Lyon played in the development of education in the United States.	2
257	5	To exhibit interest in the growth of America since 1850 in both social and cultural fields.	2
258	5	To show attention to the famous song of 1898.	1
259	5	To show appreciation for the architectural design of the Palace of Dawn.	1
260	5	To show interest in some of the buildings and overall appearance of the small villages.	1
261	1	To recall that the U.S. did not enter W.W. I until 1917.	2
262	5	To notice the caption Have A Date.	1
263	1	To list the allied powers involved in the division of Germany after World War II.	3
264	3	To associate the scientific discoveries of the U.S. scientists to the maintenance of a position as a world power by our country.	4
265	3	To associate Bernstein, Grandma Moses and Calder with their contributions to our culture.	3
266	1	To recognize Emerson and his stress of the importance of the individual.	4
267	5	To exhibit preference for the pictures of the Jefferson and Lincoln Memorials.	1
268	2	To compare this early reaper with earlier, more primitive harvesting equipment before it and with a modern-day combine.	1
269	3	To explain how "cloverleaf" construction represents sensible highway planning in today's America.	4

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
270	3	To evaluate the usefulness of the compass to Columbus.	2
271	2	To identify the early New England colonies and the land claimed by the French and the English.	2
272	5	To show an interest in the early meeting place of the first representative assembly in Virginia, the House of Burgesses in Williamsburg, V.	1
273	5	To notice some men who were leaders in the early colonies; men like William Byrd and Cotton Mather.	1
274	1	To recall the two main ships by name and nations represented.	3
275	1	To list how many stars and stripes the first flag had.	1
276	1	To recognize the application of the 18th Amendment which was prohibition and the smashing of the "stills".	2
277	2	To describe the foreign problems that faced our young nation and to identify the nations that were involved.	5
278	2	To compare the old dirt road system in early America to today's modern 4 lane expressways.	2
279	5	To evidence appreciation for the hardships encountered by the early pioneers as they pushed back the frontiers over the Wilderness Road.	3
280	3	To associate the early missions in California to the Spanish missionaries and Mexico.	2
281	5	To notice the Mormon Temple as an example of religious consecration.	4
282	2	To select those things in the illustration that should be added and subtracted to recreate the "living" Virginia City of 1876.	5
283	5	To concentrate on the speaker and audience as examples of good speaking, good listening and freedom of speech.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
284	2	To critize a policy of economic regionalism.	4
285	3	To associate modern heroic feats of under ocean and space travel with earlier American Pioneers.	2
286	5	To notice some inventors who contributed much to American progress: especially men like Alexander Graham Bell and Thomas A. Edison.	1
287	3	To associate the change in warfare tactics over the years; especially, the use of airplane and tank in modern warfare.	3
288	2	To describe the awfulness of modern warfare, as to the ruination of Germany in World War II.	3
289	2	To locate the line of truce near the 38th parallel and the major cities of Korea.	3
290	2	To describe the progress of man from the ancient concept of knights in armour to modern rocketry.	5
291	1	To list the important agricultural products of the Pacific northwest.	4
292	5	To exhibit attention to the rugged Pacific coast and its influence upon the Northwest.	2
293	2	To compare the early form of travel folders as to the colorful ones we have today.	2
294	3	To interpret the role played by Prince Henry of Portugal in the discovery of the New World.	3
295	2	To describe the cruelty of the Spaniards in conquering the Inca chief of Peru.	3
296	1	To recall the explorers of England and Holland and the land claimed by these explorers.	2
297	2	To compare the easy life of the plantation owner with that of the life of the slave.	1
298	3	To relate James Wolfe's supreme sacrifice to the importance of the Battle.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
299	1	To recall the route taken by Paul Revere and the location of the first battles of the American Revolution.	3
300	1	To list thirteen original colonies and five eventual states from the Old Northwest territory.	3
301	5	To appreciate the strong character of Perry during the low point in this Lake Erie action.	3
302	3	To associate the importance of the American Clipper Ship in trade and its role of importance to the American shipping industry.	1
303	2	To contrast the early political campaigns with the campaigning done today.	2
304	2	To compare the White House in 1848 with the present structure.	2
305	2	To compare the National Republican Convention in 1860 and its meeting place with the modern political conventions of today.	1
306	3	To summarize the problem during the Civil War: two soldiers, two flags, but only one country.	1
307	5	To be attentive to the fact our country has been favorably endowed with important natural resources.	2
308	5	To show interest and appreciation for American painters, such as Winslow, Homer's "A Fair Wind."	1
309	1	To name three political parties Bryan claimed to represent in the election of 1896.	3
310	4	To compute from the scale of miles and directions some statistics concerning the length and width of the Panama Canal.	3
311	2	To judge whether or not the map suggests that the arrival of American troops made any difference in the eventual outcome of the war.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
312	1	To recognize the role of the General Assembly in the U.N.	3
313	5	To note America's system of coins being: 1¢, 5¢, 10¢, and 25¢.	1
314	2	To analyze the inconsistencies between the practice of public officials swearing on the Bible and the principal that no religious test shall be required as a condition to holding office.	4
315	1	To recognize that the 20th Amendment ("Lame Duck Amendment") does not refer to a hurt duck, but is actually referring to senators and representatives who lost out in elections and they were labeled "lame ducks".	1
316	1	To recall that a president's term of office is 4 years.	1
317	5	To notice that all states have their own seals, which symbolize their particular place in the history of the Union.	1
318	5	To exhibit appreciation for the vastness of the importance of America in its various roles today.	3
319	1	To recognize ancient trade routes in relationship to modern day countries.	3
320	2	To identify the geographical barriers that were encountered in the search for the Northwest Passage.	2
321	2	To compare English and Spanish achievements during the period of 1492 to 1775.	2
322	2	To compare the somewhat characteristic architecture along the colonial seaboard to that of governmental buildings today.	3
323	2	To compare the various types of colonial lighting with the types of lighting we have today.	4
324	2	To explain the purpose behind the design and construction of a blockhouse.	3

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
325	3	To formulate possible reasons for a growing feeling of resistiveness which was becoming evident in the New World.	3
326	3	To interpret the Intolerable Acts from the British point of view.	3
327	2	To compare the military activities of the Patriots in the northern and southern areas.	2
328	1	To repeat the important events which led to independence for the American Colonies.	2
329	5	To notice the deliberation involved in developing the Constitution.	2
330	1	To state the importance of the state capitol building in Maryland.	2
331	2	To find in the illustration various forms of early transportation.	2
332	2	To describe a typical railroad station, using the illustration.	2
333	1	To recognize the relationship in time between Western expansion and other outstanding events in the U.S.	2
334	5	To show appreciation for poems and poetry, especially those which depict deep emotional feelings based upon historical events.	3
335	1	To recognize the three main groups of adventurers in Texas and even though they were different each contributed for the start of the Lone Star State.	2
336	3	To hypothesize as to the effectiveness of a few people. (Must be well organized, have a belief or common goal, have genuine interest in up grading standards).	4
337	2	To contrast the old Civil War artillery with modern day field artillery.	3

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
338	1	To list the major battles in which Lee was repulsed and kept away from Washington.	2
339	3	To conclude that rivers were used extensively in the early settling of the U.S. east of the Rocky Mountains.	2
340	2	To contrast the Indian population of today with that of the Indian war period.	2
341	5	To show interest as to how an early assembly line looked and functioned.	1
342	2	To find similarities and differences between craft unions and industrial unions.	3
343	1	To state the condition of our land today if our Natural Resources were not conserved.	2
344	1	To recognize the rapid social development in the last century.	2
345	5	To exhibit an appreciation for the cultural contributions of various ethnic groups.	5
346	2	To compare Teddy Roosevelt with other great Americans.	5
347	3	To hypothesize that if U.S. hopes to improve the standards of living of any groups of people, we must establish a successful health program for them.	4
348	1	To recognize the attention given to leisure time of members of our Armed Forces.	3
349	2	To describe the Normandy Invasion from the Illustration.	4
350	5	To show an interest in the various types of people that go to make up our neighbors.	4
351	3	To explain the need for a network of locks in the St. Lawrence Seaway.	3
352	2	To explain several possibilities for the people disappearing from Roanoke.	3
353	4	To construct an overlay map (using onion-skin paper to trace this map) and plot the events in the "Time Line of Discovery and Exploration" (opposite page) in the appropriate places on this map.	4

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
354	2	To explain why travel was difficult in 17th Century New England.	2
355	2	To compare the clothing, trappings, regalia . . . evident at this wedding with a church wedding which you have attended.	3
356	5	To evidence interest in why anyone would bother to keep an inkwell all these years.	3
357	2	To describe the importance of a surprise attack in times of warfare.	3
358	3	To describe the scene and the expected result of such drills.	3
359	5	To show appreciation for the Indian chief and pay attention to Fort McHenry where the inspiration was for Francis Scott Key to write our National Anthem: "The Star-Spangled Banner."	4
360	1	To recall the name and years served of the 4th President of the U.S.	1
361	5	To exhibit appreciation for frontiersmen like Daniel Boone who blazed the trail for the Wilderness Road.	3
362	1	To list the five principal early routes across the Appalachians to the West.	2
363	1	To recognize John Quincy Adams as the 6th President of the U.S. from 1825 to 1829.	1
364	5	To notice how the early prospectors panned for gold in the early gold rush days.	1
365	2	To contrast relations between the increase in cotton production and the use of child labor in cotton mills.	3
366	5	To be attentive to the early ways in which one can enter business such as being a paper boy, and the low cost of the first newspapers.	2
367	1	To recall the name and years of service of the 19th President of the U.S.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
368	3	To relate the importance of Charles Goodyear's accidental discovery of vulcanization of rubber to the importance of the rubber industry today.	4
369	2	To judge the contribution by the very rich to our society.	3
370	5	To evidence approval of one of the greatest sea victories of the American Navy during the Spanish-American War, when Dewey's fleet defeated the Spanish fleet in the Battle of Manila Bay.	3
371	2	To compare the type of weapons and uniforms worn by the American soldiers in the Spanish-American War, as compared to American soldiers in S. Viet Nam.	3
372	3	To relate industrial might to military might and in turn to the quest for peace and freedom.	3
373	1	To name a President of the U.S. who once lead NATO.	2
		MATHEMATICS OBJECTIVES	
374	1	To write several other symbols that name the number 2.	4
375	5	To show interest in the applications of arithmetic skills.	1
376	2	To identify components of the illustration with appropriate rational numbers (1/4, 1/2, 3/4, 4/4) so as to find existing relationships among components and express these relationships as 1/4 + 1/4 + 1/4 + 1/4 = 4/4; 1/4 + 3/4 = 4/4 etc.	3
377	4	To compute differences by use of the number line.	3
378	2	To find similarities between the conditions of the problem and the illustration.	3
379	1	To recognize that "and" means "intersection".	2
380	1	To recall the order of the elements on the number line.	1

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
381	3	To generalize from the information contained in the illustration that the intersection of a line and a plane is a point.	3
382	3	To formulate principles for the addition and subtraction of line segments.	3
383	4	To construct a right triangle being given the hypotenuse and one acute angle.	4
384	4	To construct a pyramid whose base is congruent to a given square and whose sides are congruent to given triangles.	4
385	5	To notice that the shape of a prism is not always rectangular.	2
386	4	To apply correctly the Pythagorean rule.	3
387	2	To identify corresponding parts of similar triangles.	3
388	2	To identify corresponding parts of similar right triangles.	3
389	4	To apply the definition of a ray to the rays in the illustration.	2
390	2	To compare the ∠s sketched in the illustration with the student's concept of a rt. ∠ and to estimate the measure of each ∠ by this comparison.	1
391	2	To identify the simple closed curves formed by the edges of a pyramid.	3
392	2	To identify the replacement set and the solution set for the open sentence, $2x = 10$.	3
393	3	To interpret the use of a vertical number line in graphing domain of a variable (second).	3
394	3	To restate the numeral represented by the group of dots in the following bases: 10, 9, 8, 7, 6, 5, 4.	5
395	4	To apply principle of binary numeration system (computer).	3
396	1	To recall an angle in the union of two rays having a common end point.	3
397	2	To compare the measures of the two angles in the illustration.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
398	4	To use the figure with information from the illustration to solve problems relative to the illustration.	4
399	2	To identify the pairs of corresponding angles formed by two parallel lines and a transversal.	3
400	4	To construct AB parallel to CD using knowledge that alternate interior angles are equal in measurement.	5
401	4	To construct the bisector of an angle and show why the resulting angles are congruent.	4
402	1	To state the solution set of $2r < 4$ and $r \geq -1$ from the number line graph.	4
403	1	To recognize the graph of $x \geq 2$ on a coordinate plane.	3
404	5	To show interest in the illustration itself to the related unit being studied.	4
405	2	To distinguish between different types of figures and angles of each; relationship of number of sides to angle measurement.	1
406	4	To apply principle of Pythagorean Theorem.	3
407	1	To recognize the component parts of a circle.	2
408	4	To assist the student in applying information already obtained concerning certain types of figures.	2
409	2	To find the area of the shaded regions in the drawing.	5
410	1	To recall area formulas that relate to figures in drawing.	3
411	1	To name the geometric figure in the illustration.	1
412	1	To recognize two perpendicular planes.	2
413	1	To name the geometric figure illustrated and also label the faces and the base.	2
414	3	To predict the formula for finding volume of pyramid.	3
415	1	To state facts from a circle graph.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
416	2	To identify the event represented by the intersection shown in diagram C.	5
417	3	To formulate a question for the given facts.	1
418	1	To recognize a fraction in terms of a set of objects.	2
419	2	To explain use of percents and their use through newspaper media.	3
420	3	To interpret information to give bearing (Navigation use).	3
421	2	To explain circumference of a circle.	2
422	1	To reproduce the formula for the volume of any prism.	2
423	4	To apply information already known to perform the work on the new problems, brought out in the illustration.	5
424	4	To solve for area (total surface) and volume of a cylinder.	4
425	5	To notice one method of paying taxes.	1
426	4	To solve for total surface area and volume of prisms.	3
427	5	To exhibit interest in the application of the binary system to electronic computers.	2
428	3	To generalize that if two fractions name the same point then the two fractions are equal.	3
429	5	To exhibit interest in the origin of our numeration system.	1
430	4	To apply rules for measuring to the illustration.	2
431	5	To show appreciation for accurate measurements.	3
432	2	To compare the amount represented by 1% with that represented by a fraction of a per cent.	4
433	5	To show interest in arithmetic as it applies to sports.	2
434	1	To recall the definition of a right △.	1
435	1	To recall the definition of a scalene △.	1
436	1	To recall the meaning of the terms arc, circumference, and semicircle.	4

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
437	3	To generalize that the perpendicular bisector of a segment will pass through the center of the circle.	4
438	4	To construct an equilateral triangle.	3
439	4	To compute the complement of a given angle.	3
440	3	To conclude that the sum of the measures of the acute angles of a right triangle is 90 degrees.	3
441	3	To generalize that the perpendicular drawn to the base of an isosceles triangle bisects the base.	4
442	4	To construct an angle of 90 degrees.	2
443	2	To identify the points on the positive side of a number line.	3
444	4	To use the number line for addition of integers.	3
445	4	To solve for the volume by which a given prism exceeds a given pyramid.	4
446	3	To predict that the volume of the decoration can be found by finding the volume of one pyramid and doubling that value.	2
447	3	To generalize that doubling of the radius of a sphere results in multiplying the volume of 2^3.	4
448	2	To compare the relative parts of similar figures.	2
449	2	To compare the components of a circle graph.	5
450	2	To identify the points designated in the illustration with distance north or south of the equator measured in degrees.	1
451	1	To recognize the Mercator projection.	2
452	4	To use the table of squares and square roots to find the square root of $8^2 - 5^2$.	4
453	5	To notice that he is on his own.	1
454	5	To show interest in the situations from which practical problems arise.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
455	2	To compare the relative values of the entries on the graph.	3
456	1	To recognize the three steps of deductive reasoning.	2
457	2	To distinguish the proper reason for a statement from many choices.	4
458	3	To explain why he believes the lines are parallel.	3
459	5	To exhibit interest in testing his knowledge.	1
460	4	To solve for the number of degrees in the supplement of an angle.	3
461	4	To use the number line to add signed numbers.	3
462	2	To identify the values filled in on the number line with the elements required in the truth set of the two sentences.	3
463	4	To apply concept of corresponding angles.	4
464	3	To generalize that the sum of the angles of a triangle is 180°.	3
465	3	To combine given information to find the unknown side of a parallelogram.	4
466	4	To apply the rule for finding area of a triangle.	4
467	2	To find the measure of the angles by identifying pairs of angles with relationships previously learned.	4
468	4	To compute the various components of a prism.	4
469	2	To separate complicated plane figures into simple plane figures for purpose of computing area.	5
470	3	To hypothesize that the segments drawn from the midpoint to the opposite vertex meet at a point that is equidistant from the three vertices.	4
471	4	To compute length from scale drawings.	3
472	1	To recall various shapes of triangles.	2
473	4	To apply knowledge of plane figures to the illustration.	5

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
474	4	To apply the pythagorean rule to the question of rationality.	5
475	5	To identify corresponding parts of similar figures.	4
476	4	To compute the length of the leg of a right triangle knowing the hypotenuse and an acute angle.	3
477	2	To explain the meaning of conditional sentences by means of Venn diagram.	3
478	4	To construct a figure by following the perscribed method.	3
479	4	To construct congruent triangles given a segment and two angles.	4
480	1	To recognize the perpendicular bisector of a line segment.	3
481	4	To apply knowledge of alternate interior and straight angles to computation of angles.	3
482	5	To show interest by asking what you call this kind of parallelogram that looks like a square that had been pushed out of shape.	1
483	4	To use the unit region to find the measure of the larger region.	1
484	3	To combine components so as to organize information in illustration in a different way from that given.	5
485	3	To generalize that the inner figure is a square.	5
486	4	To apply the definition of a convex set.	2
487	4	To write a geometric proof.	4
488	1	To recognize the value of different grouping. To reproduce grouping from base 10 on down to base 4 and base 2.	4
489	1	To recognize a given set of numbers shown by graph of a number line.	2
490	2	To explain addition of whole numbers by using the number line.	2
491	1	To name the elements of the set from the graph, beginning with the smallest.	1

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
492	3	To explain that three points not in a straight line determine one plane.	3
493	1	To recognize and be able to reproduce the different parts of an angle.	2
494	4	To state the different ways used to name an angle.	2
495	4	To classify angles by measurement (must be able to use protractor).	4
496	1	To recall the three basic assumptions about geometric figures.	2
497	4	To construct a triangle having the three sides equal to three given line segments.	3
498	2	To select pairs of congruent figures.	4
499	1	To name the corresponding equal parts of the two triangles.	2
500	3	To combine information to develop formula for area of parallelogram.	3
501	3	To formulate a generalization for the total area of any right circular cylinder.	5
502	4	To compute the volume of concrete used in and the surface area of the illustrated conduit.	5
503	2	To explain equivalent ratios by use of sets.	3
504	5	To evidence interest in the application of trigonometry to find height of building.	4
505	4	To solve for unknown distance through application of Pythagorean theory in special types of right triangles.	4
506	4	To compute measure of line segments through use of previous learned rules.	4
507	1	To name the elements of the set on the graph.	3
508	2	To locate points in a coordinate plane if the ordered pairs are given.	3
509	5	To show appreciation for graphs in showing cumulative frequency.	4

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
510	1	To recall Pythagorean theorem and how used.	2
511	2	To explain use of Pythagorean theorem in special types of right triangles.	4
512	1	To name intersections (set) of lines. (Presuming they know lines as sets of points.)	3
513	4	To apply principles of positional notation to illustration by grouping.	2
514	4	To perform, by construction, the division of a given line segment into four equal segments.	3
515	2	To select the construction techniques and use them to copy the designs.	5
516	2	To find existing relationships among components in drawing.	3
517	4	To construct an angle congruent to a given angle and show why they are equal.	4
518	2	To explain another approach to Pythagorean theorem.	5
519	4	To compute measure of segment by use of similar triangles.	4
520	3	To predict various combinations of three numbers taken two at a time.	4
521	4	To apply set intersections to plane figures.	4
522	2	To find the number of 0-, 1-, and 2- simplexes formed by drawing diagonals on the faces of a right triangular prism.	5
523	2	To find the number of vertices, faces, and edges in the geometric figure illustrated and show that Euler's formula does not apply.	4
524	3	To generalize that the intersection of two planes is either empty or a set of points (straight line).	3
525	2	To describe the relationship between the vertical line and the intersecting lines in the plane and also to the plane itself.	3

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
526	2	To describe an algebraic relationship by use of number line (geometric).	3
527	1	To reproduce the method for reading a meter and of computing the cost of electricity.	5
528	2	To separate the components of the illustration so as to identify disjoint sets.	2
529	2	To identify and compare components in the illustration so as to find similarities and differences to be used in recognizing diameters, chords and secants.	3
530	1	To recognize an isosceles triangle.	3
531	4	To construct the perpendicular bisector of a line segment.	3
532	4	To perform addition of common rational numbers with the aid of a number line.	5
533	2	To identify points in a plane by associating each point with an ordered pair of real numbers.	3
534	3	To generalize that two triangles with congruent angles and sides in proportion are similar.	4
535	4	To use trigonometric ratios in solving right triangles.	5
536	2	To identify direct and inverse variations.	4
537	3	To conclude that the ratio between the circumference and diameter of a circle is constant.	5
538	1	To recognize conditions whereby a line is perpendicular to a plane.	5
539	3	To generalize that the volume of a right prism is equal to the sum of the unit volumes that make it up.	3
540	1	To recall that the volume of a right circular cone is 1/3 Bh.	3
541	1	To recall the definition of a set and of an element of a set.	3
542	4	To use information known that involves the illustration to apply rules concerning the new number line.	3

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
543	4	To compute the total distance driven in 3 days and the number of miles above the average on the trip.	4
544	3	To organize information in different way (use of proportion) to solve problem.	3
545	3	To predict the least and the greatest measures of segments (assuming they know all measurement is approximate).	4
546	1	To recognize the various types of angles.	3
547	1	To list the characteristics required for a definition of adjacent angles.	3
548	3	To hypothesize principles involved when parallel lines cut by transversal (perpendicular and oblique).	4
549	1	To reproduce the diagram showing the construction of a line through a given point and parallel to a given line and then show why they should be parallel.	4
550	2	To find the area of a rectangle by application of the definition of area.	3
551	4	To compute length of leg of a right triangle a form of the Pythagorean theorem.	4
552	2	To use the number line to illustrate the meaning of the expression 'directed numbers'.	3
553	4	To use the information known and given that involves the illustration to solve the problems connected with the illustration.	3
554	4	To compute length of side of a right triangle using sine function.	4
555	5	To evidence interest in the application of trigonometry in finding nonmeasureable distances.	5
556	2	To compare several methods for finding altitude of right triangle. (Trig. and Pythagorean)	4
557	2	To separate pertinent facts from Venn diagram. (Knowledge of set intersection.)	4

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
		SCIENCE OBJECTIVES	
558	2	To compare the size of Fahrenheit and Centigrade degrees.	2
559	2	To explain the cause of wind.	3
560	3	To associate changes in air pressure with changes in the type of weather.	3
561	1	To recall the position of electrical charges in clouds and how lightning strikes.	4
562	2	To locate varying frost regions found in the United States.	2
563	5	To show light conditions during day-light hours in Alaska, which is different from our area.	1
564	3	To explain the suns shadow upon the earth.	3
565	4	To use to understand relationships of degrees of the earth to the time zones.	2
566	5	To notice the multitude of stars in a small area of the heavens.	1
567	5	To exhibit interest in constellations.	1
568	5	To show appreciation of the speed of light in terms the student can better understand.	2
569	2	To find why the different phases of the moon occur.	3
570	5	To evidence interest in wave action and energy potentials.	1
571	5	To evidence interest in the size of the Niagara Power plant.	1
572	3	To evaluate the operation of a nuclear power plant relative to other kinds of power plants.	5
573	4	To apply a given procedure for conducting the experiment.	4
574	1	To recognize how the mobile radio telephone allows the driver to communicate.	2
575	2	To compare the similarities and differences in action of these two traps.	2
576	3	To explain just how soap is able to remove dirt.	2
577	1	To recognize the proper method of caring for the teeth.	1

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
578	5	To evidence interest in the damage done to plants by insects.	1
579	3	To associate the tiny tree frog with insect control.	1
580	5	To show appreciation for the processing of foods bought in the grocery store.	2
581	5	To exhibit an appreciation for the amount of preparation that our fuel requires.	1
582	5	To exhibit an interest in the importance of coral in the formation of atolls in certain areas of the Pacific Ocean.	2
583	1	To recall (1) the appearance of a typical blast furnace and (2) its product, pig iron, which is obtained by using very high temperatures.	2
584	1	To recognize the different forms water may take.	2
585	3	To explain that the rapid evaporation of the ether removed enough heat with great enough rapidity to freeze the water.	4
586	1	To recognize that steam power has been used to operate engines for about 350 years.	
587	5	To notice that many modern machines make use of electricity.	4
588	3	To summarize the Edison effect in words subsequent to pupil analysis of the diagram and the reading of the text.	4
589	1	To recall that muscles work in pairs with one opposite to the other as we bend and straighten our arms.	1
590	1	To recognize the blood plasma may be administered to seriously injured persons in order to save life.	1
591	1	To recall that a balanced diet, cleanliness, and good general health contribute to a healthy appearing skin.	1

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
592	1	To reproduce the sequential explanation of how sound travels through the outer ear, three bones of the middle ear, and into the inner ear to the auditory nerve.	3
593	3	To associate the development of medical science from the fourth century to the present by the example of the barber pole to the stethoscope.	4
594	1	To recognize that when a well is situated so that the cesspool drains into the well, the well may be polluted.	2
595	5	To notice that there is a method of maintaining life through the use of an artificial heart when the blood supply to parts of the body is threatened during an operation.	4
596	3	To interpret the complex highway interchange (1) by showing the direction of traffic in all lanes, and (2) explaining its safety advantages compared to more traditional highways.	4
597	3	To explain the importance of watertight doors and other safety devices used on modern ships.	3
598	1	To recall the steps involved in recording of sound on the film of talking pictures; to recall the steps involved in the changing of the sound track on the film to sound so that the sound can be heard by persons.	5
599	4	To construct a thaumatrope and use it to show that our eyes seem to see an object differently from what is actually present.	3
600	1	To recall an example of how television is adapted to modern military usage.	2
601	3	To explain in a simple way the concept of faunal succession in the transformation of a body of open water into a bog then into dry land.	5

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
602	1	To recall four insects which are notorious for their destruction of trees and crops.	1
603	1	To recall that the Van de Graaff generator uses friction between a moving belt and a brush to build up negative charges on a metal sphere.	2
604	4	To construct the model and apply the principle of terrestrial magnetism to the behavior of the constructed model.	5
605	4	To apply the given procedure and observe the changes in the properties of iron and sulfur.	4
606	5	To show interest in how chemistry has developed new products for our every-day use.	1
607	2	To compare limestone with other building materials.	3
608	2	To compare fossilized skeleton of a fish and a plant.	2
609	3	To conclude that prevention of water runoff is beneficial to our soil and economy.	3
610	2	To describe how a coal mine operates.	3
611	4	To apply rules to the illustration about how air pressure makes the instruments work.	3
612	5	To show interest in storm warning signals in areas not found in this part of Indiana.	1
613	1	To list different insulating materials and where each is most likely used.	3
614	4	To use the diagrams in preparing a demonstration showing the scientific principles relative to magnets.	4
615	5	To evidence interest in the method of fueling a nuclear reactor.	1
616	2	To find existing relationships between dark and light areas of the photograph and the veining of a leaf and the uptake of radio-active fertilizer.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
617	4	To use in solving problems related to the principles of the lever.	4
618	2	To identify three ways of figuring the mechanical advantage of a block and tackle.	3
619	3	To prepare a working model of a light bulb.	4
620	3	To associate the pattern of a sound wave with the radio telescope.	3
621	1	To recognize the arrangement of colors in the spectrum of white light and the uses of the spectrum in research work.	5
622	5	To evidence interest in the first satellite sent into orbit and a proposed orbiting of the Atlas space station.	3
623	2	To compare the different types of rockets according to their use.	4
624	5	To evidence interest in the structure of the Telstar satellite.	2
625	5	To show a desirable interest in the size, complexity, and uses of the 200 inch Hale telescope on Mount Palomar.	3
626	2	To compare the relative amount of the electromagnetic spectrum which is of visible light to the balance of the electromagnetic spectrum.	3
627	4	To perform the experiment on extraction of chlorophyl with alcohol from leaves.	5
628	2	To explain the behavior of light rays as they pass through the two most common types of lenses.	4
629	2	To compare the differing electronic configurations of four example elements as shown by drawings symbolizing the nuclei and electron shells.	3

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
630	2	To explain that the difference between two compounds which have the same number of atoms of the same elements is dependent upon the structural arrangement of the atoms within a molecule of the compound.	5
631	4	To perform the two simple operations of (1) transferring solids into a test tube with a paper trough, and (2) stuffing a plug into a test tube.	3
632	5	To evidence interest in the size and shape of the cyclotron.	1
633	5	To exhibit an interest in the massive size, complexity, and workings of the cosmotron.	2
634	5	To concentrate on the amount of electricity that can be produced by nuclear fission.	1
635	5	To show a heightened interest in electronics due to study of the illustration of the phenomenon of electron energy demonstrated by the Crookes tubes.	3
636	5	To show an interest in the control console of a computer and an awareness of the operator to the machine.	2
637	2	To differentiate between a first-generation computer and a second-generation computer as to the improvements made in the second-generation computer over the first-generation computer.	5
638	3	To hypothesize as to the likenesses and differences between frozen water and water that is not frozen.	5
639	2	To describe the overall appearance of a piedmont glacier.	3
640	1	To recall certain information about the U.S. naval explorer scientist, Charles Wilkes, who (1) led a large scientific expedition in the "Southern Sea", and (2) sighted and named Antarctica.	3

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
641	1	To recognize a pictorial model representing molecules in motion as being illustrative of kinetic motion.	2
642	5	To show a questioning attitude and interest concerning hurricanes after (1) studying the photograph, and (2) responding to the questions asked with the illustration.	4
643	2	To analyze the effect of different positions of airfoils of a model airplane in a moving stream of air upon the action of the airplane.	5
644	5	To evidence interest in the Explorer satellite by seeking more information about it and its mission.	2
645	4	To perform the experiment using the method given.	2
646	3	To associate the bubbles and liquid oxygen to the idea that air is invisible but still occupies space.	2
647	2	To relate the presence and absence of marbles under the coffee can to the action of ball bearings and friction bearings.	3
648	5	To be attentive to the fact that air in the cities may become polluted with smoke and other impurities.	3
649	3	To hypothesize ideas on what uses may be made of radioactive isotopes as tracers.	3
650	3	To associate the clouds of mist around the rocket with the liquid oxygen described in the text.	3
651	5	To be attentive to the fact that the arrangement of the atoms of any certain molecule of matter has a definite pattern and the molecule is of a certain shape.	4
652	4	To apply the given procedure for conducting the experiment.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
653	5	To show considerable interest in the electrical distribution model of typical country side.	4
654	2	To compare the transferring of heat energy in fire and that of electricity.	2
655	1	To recall the general shape of a cinder cone volcano based on analysis of the picture.	1
656	2	To describe how the movement of powerful ocean waves may change the contour of the shoreline.	4
657	2	To contrast the two results of nature's changing the surface of the earth to the pleasure of the vactioner.	3
658	1	To recognize the two types of fractures which may result when the mineralist breaks a rock with his hammer.	3
659	4	To classify experiments that could be done to test the silver dollars.	3
660	1	To recognize the relative positions of the sun, moon, and earth which result in a total solar eclipse.	2
661	1	To recall (subsequently) that analysis of the spectrum of a glowing object can be used to identify certain substances in that object.	2
662	1	To recall the relative positions of the orbits of the planets in order of distance from the sun.	3
663	5	To notice that there are aids on the market which will aid the student in his study of stars and constellations.	1
664	1	To recall that bacteria reproduce by dividing.	1
665	1	To recall two of several possible places or activities during which a person can contract diseases such as typhoid as previously discussed in the text.	1
666	2	To identify several examples of the nervous system in action in the picture of people at a picnic outing.	2

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
667	2	To compare the manner in which a person is aware of the presence of light and the manner in which an earthworm is aware of the presence of light.	4
668	3	To associate the increase of the number of people in the world with our supply of resources.	4
669	3	To relate the nodules on the roots of some plants and the supplying of the soil with a needed chemical.	5
670	3	To generalize concerning heat loss of water to air and surrounding objects based upon correct performance and analysis of the experiment and the derived data.	4
671	5	To be attentive to the fact that highly skilled technicians are needed to operate the highly technical instruments available to science today.	3
672	1	To identify the forms of matter shown in the illustration.	2
673	4	To perform the experiment in Fig. 1-23 and construct a graph of the temperature changes over a period of time.	5
674	4	To apply the procedures given to conduct the experiment.	4
675	3	To associate radiant energy from the sun with a method of utilizing it.	2
676	1	To recall the method to calculate work done.	4
677	1	To recognize parts of a door knob as it relates to a lever.	2
678	1	To recall the speed necessary to attain an orbit.	4
679	5	To evidence interest in the planets.	1
680	2	To contrast the weather described in the illustration with local conditions.	1
681	4	To perform this experiment and consider what rapid temperature changes do to the earth's surface.	3

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
682	5	To evidence interest in the problem of erosion.	1
683	4	To do the experiment for proof that roots take in water and minerals.	5
684	2	To contrast the difference water can have on soil productivity.	2
685	1	To recall the value of cats to man.	1
686	1	To recognize the value of veterinarians to the treatment of animal diseases.	1
687	2	To compare the skeleton of insects with other animals.	1
688	1	To recall the cooperative action of paired muscles for smooth movement.	2
689	5	To evidence an appreciation of the importance of proper hormone balance in the body.	3
690	5	To evidence an interest in the storage and processing of milk.	1
691	1	To recognize the dangers of youngsters playing with firearms.	1
692	4	To use the method shown to make rugs at home safe.	2
693	1	To repeat an example of a wrong belief concerned with how we know what we think we know - namely the belief of the ancients that we see by means of light rays going from the eye to the observed object.	4
694	3	To explain why the adding of heat to a solid may change the solid into a liquid.	4
695	4	To perform a simple demonstration that an insulator-cork can prevent rapid heat transfer.	4
696	5	To show a desirable interest in rocketry.	3
697	3	To associate the biochemical production of pork with the text's description of chemical change, i.e., the transformation of corn into pork.	2
698	1	To recognize that the brightness of a light varies inversely with the square of the distance.	3

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
699	5	To evidence interest in polarized light.	2
700	2	To compare the manner in which a concave mirror acts upon light waves with the manner in which a convex lens acts upon light waves.	4
701	1	To recall an application of mirrors and telescopes in a periscope used to safely observe rocket launchings.	2
702	1	To recall the relative sizes of the known planets and their orbital order from the sun.	3
703	5	To show desirable interest (1) in the picture of meteor crater, Arizona, and (2) concerning meteor impacts in general.	2
704	2	To describe the world's largest reflecting optical telescope in terms of: its size relative to the man shown using it; the visual appearance of the mirror; and the location of the man.	3
705	3	To predict the speed of the wind from the shape of the sails by the information in the Beaufort Scale.	3
706	2	To analyze the information on the annual precipitation map in order to explain why the annual rainfall differs in one section of the country from the amount of rainfall in another section of the country.	5
707	3	To explain why the rainfall is relatively little in each city during the summer and heaviest in each city during the winter season.	4
708	3	To associate the type of climate north of Montreal, Canada with the type of trees growing there.	3
709	3	To explain how the prickly pear, the jack rabbit, and the rattle snake are individually adapted to surviving in an arid climate.	4

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
710	3	To interpret the effects of forest fires on the post-fire environment on the future of the forest and wildlife.	2
711	3	To hypothesize the food of herons from their appearance and from the information in the caption.	3
712	2	To assess the nature of the climate of four different and widely separated localities based on recall of information preceding the pictures in the textbook.	4
713	2	To contrast one method used in the United States to acquire additional food with one method used in Thailand to secure additional food.	3
714	5	To exhibit an interest in the advantage which modern farm machinery and improved seed give to farmers today over the farmers of the past.	4
715	3	To associate one's-self as being able to think like a scientist.	1
716	1	To recognize some of the same structures when viewed under a microscope.	5
717	5	To notice the source of the food prepared.	1
718	3	To evaluate the use of gamma rays used in potato storage.	3
719	3	To restate the explanation of fusion in the sun (as given in the reading).	2
720	3	To associate the diagram presenting information of sodium chloride with other chemical compounds.	5
721	2	To explain the thermocouple.	3
722	5	To notice that further references other than the textbook should be used in learning and studying.	1
723	1	To recall the molecular structure in water.	3
724	5	To evidence appreciation for the variety of useful products from metals (powdered).	1

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
725	5	To evidence interest in the sawmill industry, variations in lumber of different trees and the cellular structure of wood.	2
726	5	To evidence interest in electronic control panels used in industry that can be operated by very few people who are specialized in their job.	1
727	5	To notice how a person is tested for an allergy.	1
728	3	To associate the blockage in blood vessels with some causes of heart trouble.	3
729	3	To associate blood samples with blood products.	4
730	3	To generalize regarding the boys thoughts.	3
731	3	To explain by diagrams the earth's crust movements which resulted in the formation of the Rocky Mountains.	4
732	2	To compare the method shown in the illustration with regular methods of getting useable water.	4
733	5	To evidence an appreciation for some of the instruments used in flying.	4
734	3	To explain shock waves created by supersonic planes.	3
735	2	To compare the height, number of stages, Take off Thrust, Payload orbit, payload deep space, probe and payload, moon landing of the Atlas Mercury, Atlas Centour, Saturn and Nova.	4
736	5	To be attentive to the problem of hitting a target out in space.	3
737	4	To use for finding pictures to further explain eclipses, sunspots, swirling gases thrown outward from the sun.	5
738	3	To associate radioactivity with possible danger to human life.	4
739	2	To find other uses for the type of instruments in illustration.	3
740	3	To explain how the air-conditioning machine works.	4

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
741	2	To estimate the amount of moisture held in the air at varying temperatures.	2
742	1	To recall how carbon 14 gets into plants and animals.	4
743	2	To explain how the ligaments, cartilage pads permit the spinal column to bend.	2
744	1	To label some of the vital organs of the body.	5
745	1	To state how puzzles, blocks and patterns may be used by psychology.	3
746	3	To formulate hypotheses as to how other animals might react to similar experiments.	5
747	1	To list basic human needs.	3
748	1	To recall the physical properties and actions of the three types of radiation shown in the picture.	4
749	1	To state how the neutrino was discovered in violation of the law of conservation in Physics.	4
750	5	To evidence interest in the equipment used to study the atom.	1
751	2	To find existing relationships between the simple tools pictured and simple machines.	3
752	4	To compute the mechanical advantage of each of the three machines.	3
753	1	To recall the process by which kinetic energy of gas molecules is changed into mechanical energy.	4
754	4	To apply to the illustration the scientific principle, force x distance equals work.	3
755	2	To compare the drawing of Watt's steam engine with a present day model.	2
756	4	To write an explanation of ionization (difficult).	5
757	4	To apply the procedures given in conducting a similar experiment.	5
758	1	To state all the varieties of radiant energy in their proper order.	4

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
759	1	To recognize the image formed by a convex mirror.	2
760	3	To formulate hypotheses as to the probable results of the experiment before it is done.	4
761	5	To notice the equipment used to determine a person's ability to hear.	1
762	2	To explain how lasers are produced and used.	4
763	5	To evidence interest in gear ratios and their relation to mechanical advantage.	1
764	1	To recall the parts of the plane and their function in its control.	3
765	3	To hypothesize as to why man's weight seems to decrease as the elevator in which he is standing begins to descend.	5
766	1	To recall that space stations may be rotated in order to produce a feeling of gravitational pull for those on board.	1
767	2	To compare two diagrams, which were made 30 years apart, of a typical cell for changes in knowledge of cell structure as an example of one aspect of scientific progress.	4
768	1	To recall the purpose of the antenna of the mosquito as stated by Dr. Eusebio Y. Garcia.	1
769	2	To explain why the geographical location of Los Angles may cause the area to have a greater smog problem than most other cities.	5
770	5	To evidence interest in the iceberg.	3
771	3	To describe the locations of several named places or areas in Antarctica in terms of miles and directions.	3
772	3	To summarize the main concepts shown or implied in the time chart, such as (1) lengths of duration of geologic eras (or periods) relative to each	5

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
		other, and to man's time on earth, (2) the sequence of living organisms, and (3) the age of the earth compared to how long life has existed on earth.	
773	5	To notice that there are noted women scientists as well as noted men scientists.	1
774	5	To show more interest in the described experiment of the slate-colored juncoes.	1
775	3	To interpret information and experimental data by performing the experiment and thereby reaching conclusion about the affects of leaf growth on plants.	5
776	2	To identify characteristics of these sea animals to plants.	3
777	5	To exhibit interest in the make-up of the universe.	1
778	5	To exhibit interest in the standard kilogram.	2
779	1	To recall that a vernier scale is necessary to make accurate readings in hundredths of an inch on a mercurial barometer.	2
780	4	To apply the principle which explains why the paper bends downward as air is blown across the top of the paper.	4
781	3	To explain why the ion rocket engine would be a desirable engine for deep space travel.	3
782	5	To notice the arrangement of the atoms in a molecule of stearic acid.	2
783	1	To reproduce with symbols the carbon tetrachloride molecule by means of the chemical formula, structural formula, and/or by drawing labeled circles and connecting lines for bonds.	4
784	5	To show an interest in the type of molecule which is referred to as a polymer molecule.	3
785	2	To contrast the rate of discharge of the electroscope with the elevation above sea level.	4

Illustration Number	Objective Type	Student Behavioral Objective	Degree of Involvement
786	5	To evidence interest in James Clark Maxwell and his contributions to science.	2
787	3	To formulate explanations of how some early time-measuring devices kept track of time, or indicated time of day.	3

APPENDIX J

PROCEDURE FOR IDENTIFYING VERBAL MODIFIERS

Unit of Analysis (within illustration)

Any verbal-numerical symbol or group of symbols (phrases, sentences, etc.) which are part of an illustration (identified by blue lines) and which exhibit a functional and perceptual unity, i.e.

1. functions as a discrete unit, such as a sentence, dependent clause, phrase, word, or single letter or number. (Choose largest functional unit up to sentence size)

2. perceived as a unit, as being grouped together (proximity) and separated from other groups or elements (contrast).

Note: Includes no graphic symbols, such as arrows, i.e. must be verbal-numerical

Procedure

1. Is it a sentence, i.e., does it have a subject and predicate and express a complete thought? (Includes "sentences" that do not begin with a capital nor end with proper punctuation)

    A. If a sentence, is it declarative, interrogative, imperative, exclamatory, or mathematical?
    (1) Standard English definitions apply for discriminating declarative, interrogative, imperative, and exclamatory.
    (2) Mathematical sentence is an equation, i.e., a group of mathematical symbols that state a "complete" mathematical "thought." If any words are included, the sentence is verbal rather than mathematical.

    B. Sentence may occur anywhere within the illustration, i.e., in a caption, as a title, as a label, etc.

    C. Tabulate the number of each type of sentence occurring in each illustration.

2. Is it a non-sentence, i.e., meet the test of a unit of analysis but not a sentence?

    A. If a non-sentence, does it refer to the whole picture? If so, it is a title.

    B. If it refers to only part of the picture, it is a label.

    C. If it includes a key (blocks of color, shading, or the like), it is a legend.

3. **Specific Problems**

A. Multiple choices are counted together as one, i.e., The correct area for the above figure is: (a) 32 (b) 10 (c) 5.

B. Multiple sentences or fragments, such as the following, may be counted as one: In what state is rainfall the highest? the lowest?

C. The number preceding an exercise or problem is not to be counted as a label, i.e., it is a part of the unit it numbers.

D. Each label is a unit, i.e.,

(1) each latitude or longitude designation (though not both ends of the line)
(2) each number or letter on a number line
(3) each number on a ruler or clock

E. An event together with its date are together as a unit.

F. Title, publisher, author are each counted as separate units, but credit lines are not counted.

G. Legibility--each letter of a unit must be fully discriminable to the unaided eye of a judge having 20/20 vision, i.e., missing or blurred letters eliminate a unit even if it can "readily" be inferred.